UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802-4213

OCT 2 2007

In response refer to:
2007/01353:MTM

Kevin Foerster
Project Leader
Sacramento National Wildlife Refuge Complex
US Fish and Wildlife Service
752 County Road 99W
Willows, California 95988

Dear Mr. Foerster:

This letter transmits NOAA's National Marine Fisheries Service's (NMFS) biological opinion (Enclosure 1) based on our review of the U.S. Fish and Wildlife Service's (USFWS) proposed bank protection and channel alignment project at the site of the M&T Chico Ranch/Llano Seco Rancho Pumping Plant (M&T Ranch project), and their effects on Federally listed endangered Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*), threatened Central Valley spring-run Chinook salmon (*O. tshawytscha*), threatened Central Valley steelhead (*O. mykiss*), and their designated critical habitat in accordance with section 7(a)(2) of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 *et seq.*). This biological opinion also includes a section 7(a) (2) analysis of project related effects on the threatened southern Distinct Population Segment (DPS) of North American green sturgeon (*Acipenser medirostris*).

The project is being proposed because the natural evolution of hydrologic patterns in the Sacramento River has caused the flow of water past the fish screens at the pumping plant to change in a manner that makes the fish screens less efficient. Beyond that, hydrologic modeling suggests that within the near future the river channel will probably migrate away from the pumps. Were it not for the pumps, the river could be allowed to change course without threatening streamside development. However, the ranch owns riparian water rights which are used to irrigate 11,000 acres of farmland and 4,000 acres of refuge owned or managed by the USFWS and California Department of Fish and Game (CDFG). The project is proposed as 5-year solution to enable the pumps to operate while a long-term solution is sought.

It is understood that the project described in the documents transmitted with your letter requesting section 7 consultation is an interim solution that will enable the pumping plant to continue to operate while all interested parties consider the best course of action to attaining a long-term solution. Based on the best available scientific and commercial information, the biological opinion concludes that the project is not likely to jeopardize the above listed species or adversely modify designated critical habitat. NMFS has included an incidental take statement with reasonable and prudent measures and non-discretionary terms and conditions that are necessary and appropriate to minimize incidental take associated with project actions. The listing of the southern DPS of North American green sturgeon became effective on July 7, 2006, and some or all of the ESA section 9(a)(1) prohibitions against take will become effective upon the future issuance of protective regulations under section 4(d). Because there are no section 9(a)(1) prohibitions at this time, the incidental take statement, as it pertains to the southern DPS of North American green sturgeon does not become effective until the issuance of a final 4(d) regulation, as appropriate.

Also enclosed are Essential Fish Habitat (EFH) Conservation Recommendations for Pacific salmon as required by the Magnuson-Stevens Fishery Conservation and Management Act (MSA) as amended (16 U.S.C. 1801 *et seq.;* Enclosure 2). This document concludes that the M&T Ranch project will adversely affect the EFH of Pacific Salmon in the action area and adopts certain terms and conditions of the incidental take statement and the ESA Conservation Recommendations of the biological opinion as the EFH Conservation Recommendations.

Section 305(b)4(B) of the MSA requires the USFWS to provide NMFS with a detailed written response within 30 days, and 10 days in advance of any action, to the EFH conservation recommendations, including a description of measures adopted by the USFWS for avoiding, minimizing, or mitigating the impact of the project on EFH (50 CFR 600.920[j]). In the case of a response that is inconsistent with our recommendations, the USFWS must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the proposed action and the measures needed to avoid, minimize, or mitigate such effects.

If you have any questions regarding this correspondence please contact Ms. Madelyn T. Martinez in our Sacramento Area Office, 650 Capitol Mall, Suite 8-300, Sacramento, California 95814. Ms. Martinez may be reached by telephone at (916) 930-3605 or by Fax at (916) 930-3629.

Sincerely,

Anthony C. Matos

for Rodney R. McInnis
Regional Administrator

Enclosures (2)

cc: Copy to file: 151422SWR2007SA00322
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**Enclosure 1**

## BIOLOGICAL OPINION

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| **ACTION AGENCY:** | U.S. Fish and Wildlife Service<br>Sacramento National Wildlife Refuge Complex |
| **ACTION:** | Bank Protection and Channel Alignment Project at the M&T Chico Ranch/Llano Seco Rancho |
| **CONSULTATION CONDUCTED BY:** | National Marine Fisheries Service, Southwest Region |
| **FILE NUMBER:** | F/SWR/2007/04655 |
| **DATE ISSUED:** | OCT 2 2007 |

## I. CONSULTATION HISTORY

In 1997, as part of an effort to reduce mortality to native salmonids in Big Chico and Butte Creeks, the M&T Chico Ranch/Llano Seco Rancho (M&T Ranch) fish screen and pumping facility was relocated from Big Chico Creek to the Sacramento River. The relocated diversion was designed with a state-of-art fish screen system supplying a total capacity of 150 cubic feet per second (cfs). As part of the relocation arrangement, the ranch agreed not to divert 40 cfs of their long held water right out of Butte Creek (October 1 through June 30), as long as replacement water would be guaranteed from the Central Valley Project at the new diversion located on the Sacramento River.

In 2000, bank erosion surveys identified deposition of sediments threatening pumping plant operations. Stillwater Sciences identified spur dikes as a long-term alternative for protecting the pumping plant.

In 2003, a Steering Committee was assembled that included representatives from the CALFED Bay-Delta Program (CALFED), U.S. Fish and Wildlife Service (USFWS), NOAA's National Marine Fisheries Service (NMFS), the Department of Water Resources (CDWR) and the California Department of Fish and Game (CDFG).

On November 12, 2003, the Steering Committee met for a site visit and discussed the future needs and actions.

On November 13, 2003, the Steering Committee discussed project alternatives, conceptual models, project goals, reviewed existing conditions and studies, preliminary performance measures , conflicts and uncertainties associated with simultaneously protecting river meander, pumping plant capacity and fish protection.

On November 14, 2003, the Steering Committee met to discuss project alternatives developed for current pumping plant installation, timelines, and the process for Steering Committee interaction and reporting.

On March 17, 2004, the Steering Committee met for an information workshop and continued discussion of the proposed action.

On March 18, 2004, the Steering Committee reviewed steering committee responsibilities, questions to be addressed, goals and objectives, and technical review.

On March 19, 2004, the Steering Committee prioritized major findings, conclusions, and recommendations; discussed the next steps; and set a date and made an agenda to reconvene.

On February 16, 2005, the Steering Committee met at the site to evaluate gravel bar movement. A discussion of alternatives followed and included: (1) City of Chico Wastewater Treatment Plant Outfall alternatives; (2) Off-Stream and In-Stream alternatives; (3) Groundwater alternatives (long-term solution); (4) Potential river training works at M&T pumping plant; and (5) Installation of Rock Groins (long-term solution).

On February 17, 2005, the Steering Committee discussed challenges, uncertainties and risks involved with long-term solution alternatives. The Steering Committee had a collaborative study evaluation of the alternatives.

On February 18, 2005, the Steering Committee discussed the findings, conclusions, and preliminary recommendations from the collaborative study of alternatives.

On April 24, 2006, the Steering Committee met for a project and technical review update followed by presentations of refined alternatives that included: (1) evaluation of potential river training works at the M&T pumping plant; (2) evaluation of river training works within decision matrix with two-dimension modeling; (3) evaluation of Ranney collectors within decision matrix; (4) evaluation of dredging and fish screen within decision matrix.

On April 25, 2006, the Steering Committee met to select the preferred alternative, develop the preferred alternative conceptual model framework, and develop the proposed action.

On November 30, 2006, the Steering Committee met to discuss the current engineering survey results, scenarios for moving the project ahead, and gravel bar removal. The meeting ended with a consensus to pursue the action.

On February 9, 2007, the Steering Committee met to discuss changes to the proposed action construction dates, permits needed, environmental documentation, and possible mitigation.

On March 29, 2007, representatives from M&T Ranch, Ducks Unlimited (DU), USFWS, NMFS, and CDFG met at the site of the proposed project.

On May 2, 2007, USFWS provided direction regarding magnitude of potential terrestrial effects.

On May 11, 2007, USFWS provided NMFS a draft Action Specific Implementation Plan (ASIP) for review.

On May 14, 2007, NMFS responded with comments.

On June 1, 2007, representatives from M&T Ranch, USFWS, NMFS, and CDFG participated on a conference call to discuss the comments provided by the resource agencies.

On June 6, 2007, USFWS requested section 7 formal consultation. Enclosed with the letter was a biological assessment of the proposed project.

On July 19, 2007, NMFS initiated section 7 formal consultation with USFWS.

On September 25, 2007, the project description was modified by the USFWS. The change involved moving the riparian revegetation from the bank protection area, to a location immediately upstream.

On October 1, 2007, the ASIP was revised to include rock removal at year 5 as part of the project description.

A complete administrative record of this consultation is on file at the NMFS Sacramento Area Office.

## II. DESCRIPTION OF PROPOSED ACTION

The CALFED Bay-Delta Program is a collaborative effort of 23 Federal and State agencies that seek to resolve water supply conflicts. The CALFED Bay-Delta Program Programmatic Record of Decision (ROD) set forth a collaborative means for addressing the environmental effects (adverse and beneficial) of CALFED Program actions related to improving water supply reliability and recovery/restoration of the Sacramento-San Joaquin Delta (Delta) environment and species dependent on the Delta. The ROD reflects a final selection of a long-term plan (Preferred Program Alternative), which includes specific actions, to fix the Bay-Delta, describes a strategy for implementing the plan, and identifies complementary actions that CALFED Agencies also will pursue. The Preferred Program Alternative consists of a set of broadly described programmatic actions, which set the long-term, overall direction of the 30-year CALFED Program. The Preferred Program Alternative includes: (1) the Levee System Integrity Program; (2) Water Quality Program; (3) Ecosystem Restoration Program (ERP); (4) Water Use Efficiency Program; (5) Water Transfer Program; (6) Watershed Program; and (7) Storage and Conveyance.

Of particular interest for this proposed action is the ERP, which identifies programmatic actions designed to restore, rehabilitate, or maintain important ecological processes, habitats, and species within 14 ecological management zones, including the Sacramento River. Modifying or eliminating fish passage barriers, including the removal of some dams, construction of fish ladders, and construction of fish screens that use the best available technology, is one of the programmatic actions listed as part of the ERP. The proposed action would remove sediment in order to increase sweeping velocities across the intake screens (parallel to screen); rendering the fish screens in compliance with NMFS and CDFG fish screen criteria. Fluvial geomorphic and hydrologic processes (*i.e.*, over-bank flows, deposition, and erosion) which cause main channel lateral migration and reworking of the floodplain create and sustain riparian floodplain vegetation and habitats. Hence, the proposed action would be vital in achieving the goal of the ERP, which is to improve aquatic and terrestrial habitats and natural processes to support stable, self-sustaining populations of diverse and valuable plant and animal species through an adaptive management process.

As part of a major effort to reduce the risk of mortality to native salmonids in Big Chico and Butte Creeks, the M&T Chico Ranch/Llano Seco Rancho fish screen and pumping facility was relocated to the Sacramento River in 1997. The relocated diversion was designed with a state-of-art fish screen system supplying a total capacity of 150 cubic feet per second (cfs). As part of the relocation arrangement, the M&T Chico Ranch/Llano Seco Rancho agreed not to divert 40 cfs of their long held water right out of Butte Creek (October 1 through June 30), as long as replacement water would be guaranteed from the Central Valley Project at the new diversion located on the Sacramento River.

The M&T Ranch's pumping plant is located downstream of the confluence of Big Chico Creek and the Sacramento River, on the left bank of the Sacramento River just south of Bidwell-Sacramento River State Park, about 6 miles southwest of the City of Chico (Figures 1, 2, and 3). M&T Ranch's pumping facility provides a reliable water supply to about 15,000 acres of farmland and refuge land, including over 4,000-acres of wetlands owned or managed by USFWS and CDFG that provide key wetland habitat for waterfowl and other wetland species. Accordingly, USFWS and CDFG have a vested interest in maintaining the viability of the M&T pumping facility.

Sediment deposition has posed a threat to the normal operation of the screened diversion. An encroaching gravel bar adjacent to the Bidwell-Sacramento River State Park is migrating toward the vicinity of the diversion at an unpredictable rate. The rate at which the sediment is accumulating near the fish screened intake is mostly dependant on flow conditions in the

Sacramento River because the gravel bar growth and rate of migration is accelerated during wet years. Additionally, due to river morphologic changes, the river is meandering away from the pumping facility, isolating the facilities from the Sacramento River. As a result of continued sediment deposition and river meander, the intake screens would potentially be buried by sands and gravel, and no longer receive sufficient sweeping flows, rendering the facilities incompliant with the NMFS and the CDFG fish screen criteria of at least two times the allowable approach velocity. Continued operation of an incompliant facility could result in an impact to anadromous fish in the Sacramento River and Big Chico Creek; thereby potentially curtailing pumping and water delivery. As a result, competing uses would arise from the need to protect ecosystem functions, the natural processes of the river and anadromous fish species, and the need to preserve operations of the pumping facility to provide water to agricultural and refuge lands. Thus, the USFWS proposes to provide a 5 year interim solution while a long-term and permanent solution and plans for a permanent design are being discussed.

### A. Project Description

The project is located on the Capay Unit of the Sacramento River National Wildlife Refuge. The proposed action is a 5-year, interim solution intended to maintain hydraulic conditions in the Sacramento River necessary to meet NMFS and CDFG velocity criteria at the M&T Fish Screen. The action consists of two elements: (1) place a longitudinal rock toe and tree revetment on the right (west) bank of the Sacramento River at river mile (RM) 192.5R to stabilize bank erosion; (2) remove a gravel bar (approximately 115,000 cubic yards) from the east side of the river. At the end of the 5-year period, the project revetment will either be removed, or integrated into a long-term solution. The long-term solution is considered a separate action that will require acquisition of additional permits and independent environmental review under National Environmental Policy Act (NEPA), the California Environmental Quality Act (CEQA), and the Endangered Species Act (ESA). Therefore, these future actions are not described or analyzed in detail in this biological opinion.

#### 1. Longitudinal Stone Toe and Brush Revetment for RM 192.5R

The proposed action is to place 1,520 feet of rock toe and tree revetment on the west side of the river and remove gravel on the east side of the river (Figure 4). The upstream extent of the revetment is located at the point where there has been little retreat of the bank over the nine years. The downstream end of the revetment is located at the interface between the eroding bank and the lower elevation point bar surface, which provides a total length of protection of 1,520 feet.

The primary objective of placing a longitudinal stone toe with tree revetment at RM 192.5R on the Sacramento River is to stabilize the site to protect the M&T Chico Ranch/Llano Seco Rancho pumping facility's ability to pump water until such time as a long-term solution is implemented. This project is meant to provide a 5 year interim solution while a long-term and permanent solution and plans for a permanent design are being discussed. Addition of woody material to the top and within the rock revetment provides an element of self-mitigation for loss of SRA habitat.

No bank grading is anticipated at the site. Rock will be imported to the site by truck, dumped on a 20-foot wide working area along the top of the nearly vertical 15-foot high bank, and placed in the water at the base of the bank by either a dragline or a long-reach excavator with a 33- to 40-foot reach. Excavation for the rock tiebacks would be conducted with a long-reach excavator. The rate of rock importation and the amount of stockpiled rock on the site would be determined by the contractor and Refuge Manager, based on rate of rock toe placement, to minimize stockpiling.

The volume of rock required to provide toe protection and the size of individual rocks were determined from the U.S. Army Corps of Engineer (USACE) design procedure for riprap armor (USACE 1997). Hydraulic information used in selection of the rock size (D50 = 0.75 feet) and the depth of toe scour (4.1 feet) was derived from Mussetter Engineering, Inc's (MEI) two-dimensional hydrodynamic model of the reach (Ducks Unlimited 2005). Rock volumes were increased by a factor of 1.75 to account for the use of quarry rock. Application of the design procedure resulted in a requirement of six tons of rock per linear foot of bank, for a total of 9,120 tons, including four intermediate tiebacks and the upstream and downstream tie-ins (Figure 5). The rock will extend up approximately half the bank to an elevation of approximately 120 feet above mean surface level (msl) and the base of the revetment would be approximately 30 feet wide. The top of the bench would be approximately 10 feet wide.

The brush portion of the revetment would consist of multiple, alternating clusters of trees spaced approximately 10- to 15-feet apart at two elevations. One layer would be installed on the top of the rock toe, and the second layer would be installed at an intermediate elevation to provide instream and object cover at a range of flows (Figure 10). Each tree cluster would consist of 10 to 16 trees, depending on the size of each tree, and would extend for approximately 40 to 50 feet in length. Trees forming clusters on the top of the rock toe would be oriented in varying directions and would be layered to create a dense mix of branches and roots, and would be anchored to partially sunken large boulders (minimum of 3-feet in diameter) using steel cable. Intermediate clusters of trees would be buried in the rock toe and oriented with either the root wad or branches extending toward the river from the rock toe. It is anticipated that approximately 390 almond trees would be obtained from the M&T Chico Ranch/Llano Seco Rancho for use in the brush revetment.

Valley/foothill riparian vegetation at the site is composed of mature native and nonnative trees occurring as an isolated patch between agricultural fields and the river's edge. This vegetation is located along the adjacent bank of the proposed longitudinal stone toe and tree revetment. About 250-feet of remnant riparian vegetation occurs along the most highly eroded area, and will be removed for construction. This stand of riparian vegetation is located on the top of a nearly vertical bank about 10 to 12 feet from surface water. This habitat type also occurs on the east side of the Sacramento River within and immediately adjacent to the gravel removal construction area.

Riparian habitat that provides terrestrial and aquatic habitat for special status species and species of primary management concern would be removed during construction and would be mitigated at a ratio of 2:1 (*i.e.*, two acres restored for every acre removed). Live plantings, including willow, alder, and cottonwood trees would be planted along the Sacramento River, immediately upstream from the treated bank. The vegetated area will be 750 feet long and 20 feet wide, for a total revegetated area of 0.35 acres. Removed grassland would be mitigated at a ratio of 1:1 (*i.e.*, one acre restored for every acre removed) on the USFWS Sacramento River National Wildlife Refuge.

The elevation of the top of the outboard portion of the rock berm will be approximately 119 feet. The winter period flow duration curve (Hamilton City gage (HMC) – California Data Exchange Center (CDEC) Station ID HMC), and the associated Hydrologic Engineering Centers River Analysis System (HEC-RAS) water-surface elevations, indicate that 119 feet elevation will be inundated at the 42 percent exceedence flow (15,000 cfs) that has an average winter duration of 38 days. The entire structure, including the trees and brush, will be inundated at the 25 percent exceedence flow (24,840 cfs and an elevation of 123 feet msl) that has average winter duration of 23 days (pers. comm., Harvey 2006). A flow duration analysis was not conducted to identify the flow exceedence at which the intermediate clusters would be partially or fully inundated. However, it is expected that the highest branch or root tips of the intermediate clusters would be below the lowest branch or root tips of the tree clusters anchored to the revetment bench (*i.e.*, the top of the revetment) (Figure 6). Therefore, it is expected that the intermediate tree clusters would be completely inundated greater than 42 percent of the time, and would be partially inundated substantially more frequently, thus providing velocity refuges and rearing habitat at flows that would occur during most anadromous salmonid outmigration periods.

The stone toe will have a 1:10 cross grade, which will place the outboard portion of the toe at a slightly lower elevation than the inboard elevation (Figure 7). The 1:10 grade will have the following advantages:

- It will permit construction of the upper-portion (inboard) of the structure completely out of the wetted channel.
- The outboard edges of the trees/brush revetment will "drape" over the rock at an elevation that is less than 119 feet, thereby creating SRA habitat.
- The outboard edges of the trees/brush will be inundated for longer than 38 days at 42 percent exceedence flow.
- The entire structure will be inundated for 23 days at 25 percent exceedence flow.
- It decreases the likelihood of stranding fish when high flows recede.

Rock for the toe protection would be placed in the channel with large construction equipment such as long-reach excavators and draglines or other appropriate machinery. Trees and brush would be placed in the revetment area utilizing a crane, or other appropriate machinery.

After five years, the rock and wood revetment would be removed with large construction equipment such as long-reach excavators, during the work window generally extending from October 1 through October 31. Removal activities would utilize access and staging areas, equipment and materials, personnel, and project commitments, as described for the rock placement.

## 2. Gravel Bar Removal

In addition to revetment of the west bank of the Sacramento River, the proposed action also would entail removing gravel bar material from the river to allow parallel sweeping flows at the pumping site in order to maintain the functionality of the pumping facility and fish screen criteria. The gravel bar removal would occur in three steps, which were used successfully at the site in 2001 (CDFG and City of Chico 2001). The three-step process is detailed below:

- A temporary stream crossing over Big Chico Creek would be constructed to provide heavy equipment access to the site from the M&T Chico Ranch/Llano Seco Rancho. The crossing would extend from an existing access road on the M&T Chico Ranch/Llano Seco Rancho across Big Chico Creek to the gravel bar. This crossing would include one or more corrugated metal arch culverts covered with gravel fill (Figure 11), which could be obtained from the gravel bar itself. The crossing would be a 15 to 20-foot wide road bed at the top and would extend approximately 60 to 80 feet across the span of Big Chico Creek. The crossing is designed to meet NMFS and CDFG stream crossing criteria by utilizing the Stream Simulation Design Method (CDFG 2002a; NMFS 2001b). The crossing would be removed after construction activities have been completed and the original shoreline contours restored. Some gravel would be left in the creek after removing the culverts. The stream crossing would extend to the construction site in the center of the bar *via* a compacted gravel pathway. This pathway would require some brush and small tree removal for a short distance (about 50-feet) from the crossing to the open bar. Upon project completion this pathway would be restored to its original state including necessary grading and replanting within the pathway.

- The excavation area inside the gravel bar would be excavated to about 5 feet below the fall low-flow (4,000 cfs Sacramento River Flow) water surface elevation. During excavation, a 5- to 10-foot berm would be left on the outer edge of the dry bar to separate the Sacramento River and Big Chico Creek from the construction activities. This buffer would isolate turbid water in the excavation area from the Sacramento River and Big Chico Creek during construction. Silt would settle in the excavation area and would be subject to re-suspension when high flows capture the area during the winter-spring period.

- Winter flood flows would complete the reconfiguration of the bar by inundating the excavated area and scouring the outer berm. The gravel removed from the bar would be relocated to a spoils area located approximately 1,000 feet to the east on the M&T Ranch property. The spoils site is located within the floodplain of the river, at an existing gravel storage area. The storage site would not significantly alter floodplain capacity. Gravel and sands from the bar would be dispersed evenly over the storage area and sloped toward the water to alleviate any ponding and eliminate low areas that may pond after flooding and potentially strand juvenile salmonids, Sacramento splittail, and other fishes. The gravel and sand would be made available only for river and floodplain restoration activities at a future date.

To replace the loss of riparian habitat on the gravel bar and aquatic backwater habitat on the stone dike, M&T Chico Ranch/Llano Seco Rancho would restore degraded habitat at or near the affected area. Proposed restoration activities would occur on the gravel bar and stone dike. The activities include the removal of non-native vegetation and re-vegetation with native riparian species to provide SRA and/or riparian habitat.

Removal of approximately 156,000-tons of additional material could be expected to occur about every four years, or once within the five-year project implementation period. Figure 9 illustrates a conceptual plan of the dredging activities.

### B. Proposed Time Schedule for Construction

Construction would be performed as soon as possible, between October 1 and November 15, after required permits are issued and ESA consultation is completed. An estimated construction period for revetment and dredging activities, if weather and river conditions are appropriate, is estimated to take two weeks.

### C. Access and Staging

Access to the revetment site would occur *via* an unnamed road on USFWS property that begins at the terminus of County Road 23, south of Hamilton City in Glenn County, California. There would be a staging area west of the revetment site (Figure 10), which could potentially impact resources at a CALFED Project site that has already undergone NEPA/CEQA Environmental Assessment (EA)/Environmental Impact Report (EIR) review. The environmental compliance document for the previous CALFED project is known as the "Final EIR – Sacramento River-Chico Landing Sub-reach Habitat Restoration Planning". Roadway access to the dredging and spoils pile area would occur via River Road, near the River Road crossing over Big Chico Creek. Refer to Figure 10 for location of site access points.

### D. Equipment and Materials

Heavy equipment to be used during construction on both components of the proposed project includes bucket loader, dump truck, excavator, dragline, water truck, and grader.

### E. Personnel

A base project crew of three persons will be required throughout most of the construction period. Crew size will peak at about five personnel.

## F. Conservation and Avoidance Measures

The following actions would be implemented as part of the proposed project to avoid the potential for direct and indirect adverse impacts to environmental resources resulting from project construction and/or operations.

1. Pre-construction surveys for sensitive biological resources will be conducted by qualified biologists.
2. The project engineer will stake the limits of the construction footprint in the field. Temporary construction netting (high-visibility plastic fencing) will be placed around nearby vegetation by the contractor to provide protection from construction activities.
3. Project personnel will participate in an environmental awareness training program provided by the project biologist. Construction workers will be informed about any sensitive biological resources associated with the project and that disturbance of sensitive habitat or special-status species is a violation of the Federal ESA and Section 404 of the Clean Water Act.
4. Workers will be informed of the nearshore presence of juvenile listed fish species, including anadromous salmonids and that actions causing injury or death to fish could result in civil or criminal penalties to the individuals who commit such actions.
5. Workers will be informed of the need to carefully place rock in order to avoid impacts to juvenile fish.
6. Removed riparian vegetation will be restored at a ratio of two (2) acres restored for every acre removed.
7. Removed grassland vegetation will be restored at a ratio of one (1) acre restored for every acre removed.
8. M&T Chico Ranch/Llano Seco Rancho will develop a plan to avoid, compensate for, and enhance natural vegetation, including riparian habitats and IWM prior to, during, and subsequent to construction activities.
9. During construction of the rock toe revetment, a "veneer" of stone less than 8 inches in diameter or "pit run rock" consisting of various sizes of rock that lock together will fill interstitial spaces created by large quarry stone. These measures would reduce the presence of cavities that could be used as refuges for piscivorous fish species.
10. A qualified biological monitor would be present on site during construction.
11. M&T Chico Ranch/Llano Seco Rancho will apply for certification from the Central Valley Regional Water Quality Control Board (RWQCB) under section 401 of the Clean Water Act, and implement an Erosion Control Plan and Post Construction Stormwater Management Plan (PCSWMP).

12. A Storm Water Pollution Prevention Plan (SWPPP), provided by the contractor prior to the onset of construction activities will be implemented as required by the conditions of a National Pollution Discharge Elimination System (NPDES) permit.

13. Hazardous materials, which could be present during project construction, will be limited to petroleum products. M&T Chico Ranch/Llano Seco Rancho will develop a Hazardous Materials Control, Spill Prevention, and Response Plan (HMCSPRP) to reduce the potential effects of hazardous materials use and spills.

14. The possibility exists that fuels, lubricants, and other construction materials could enter the human environment during construction. The HMCSPRP and SWPPP will include provisions to ensure that potential effects associated with hydrocarbon use would be minimized.

15. Best Management Practices provided by the contractor will be implemented and will include:

    - Preventing any substances that could be hazardous to aquatic life from contaminating the soil or entering watercourses, including ditches and canals.
    - Establishing a HMCSPRP before project construction that includes strict on-site handling rules to keep construction and maintenance materials out of drainage and waterways.
    - Training all construction personnel in the proper use and cleanup of potentially hazardous materials.
    - Cleaning up all spills immediately according to the HMCSPRP, and notify CDFG and the Central Valley RWQCB immediately of spills and cleanup procedures.
    - Providing staging and storage areas for equipment, materials, fuels, lubricants, solvents, and other possible contaminants away from watercourses.

## G. Action Area

The action area is defined as all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR § 402.02). The action area considered in this biological opinion is in the vicinity (i.e., within 2000 feet) of RM 192.5R on the Sacramento River (Figure 3). This includes the immediate bank revetment area and access roads on the Capay Unit of the Sacramento River National Wildlife Refuge owned by USFWS and California State Parks; a 100-foot perimeter around the construction footprint; the proposed gravel bar removal site within the banks of the Sacramento River; the culvert crossing on Big Chico Creek to 100 feet downstream of the culvert crossing, riparian vegetation on the left bank of Big Chico Creek; the spoils deposit area located just inside the east flood levee; and a portion of the Sacramento River about 1000 feet downstream from the construction site (Figure 10). These designated areas are part of the proposed action area in which major construction activities would occur and where listed anadromous fish and designated critical habitat have some likelihood of being affected.

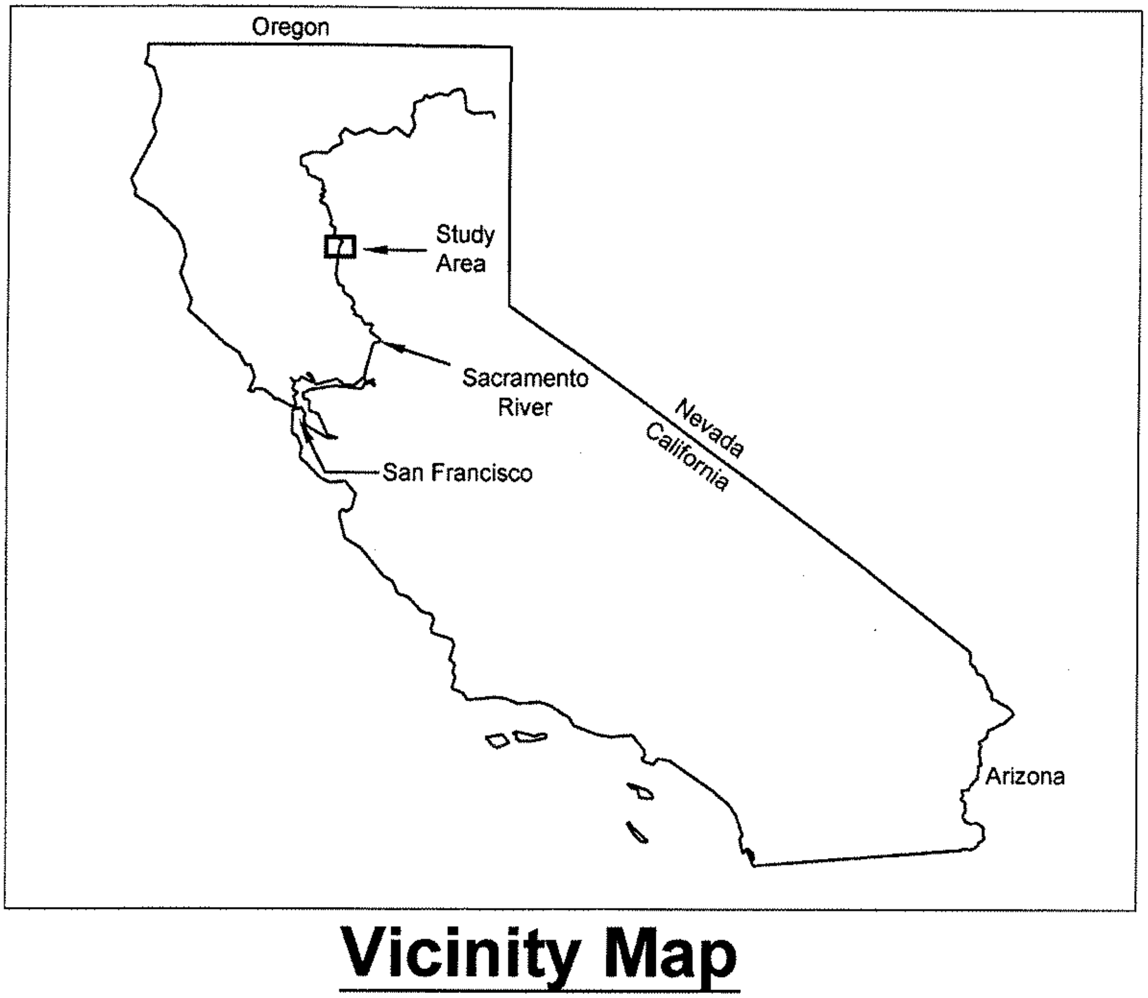



Figure 1. Regional Location Map

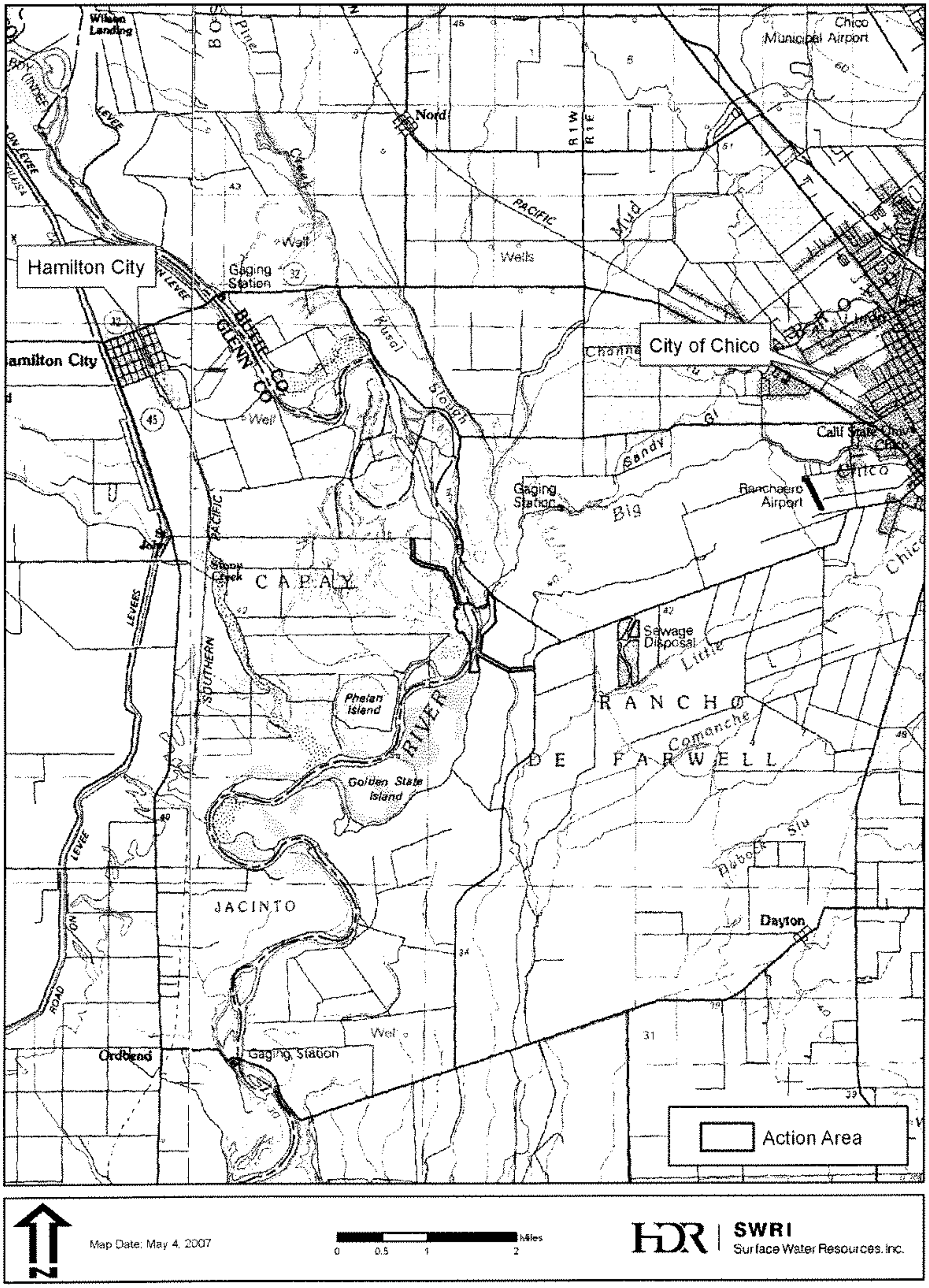



Figure 2. Vicinity Map

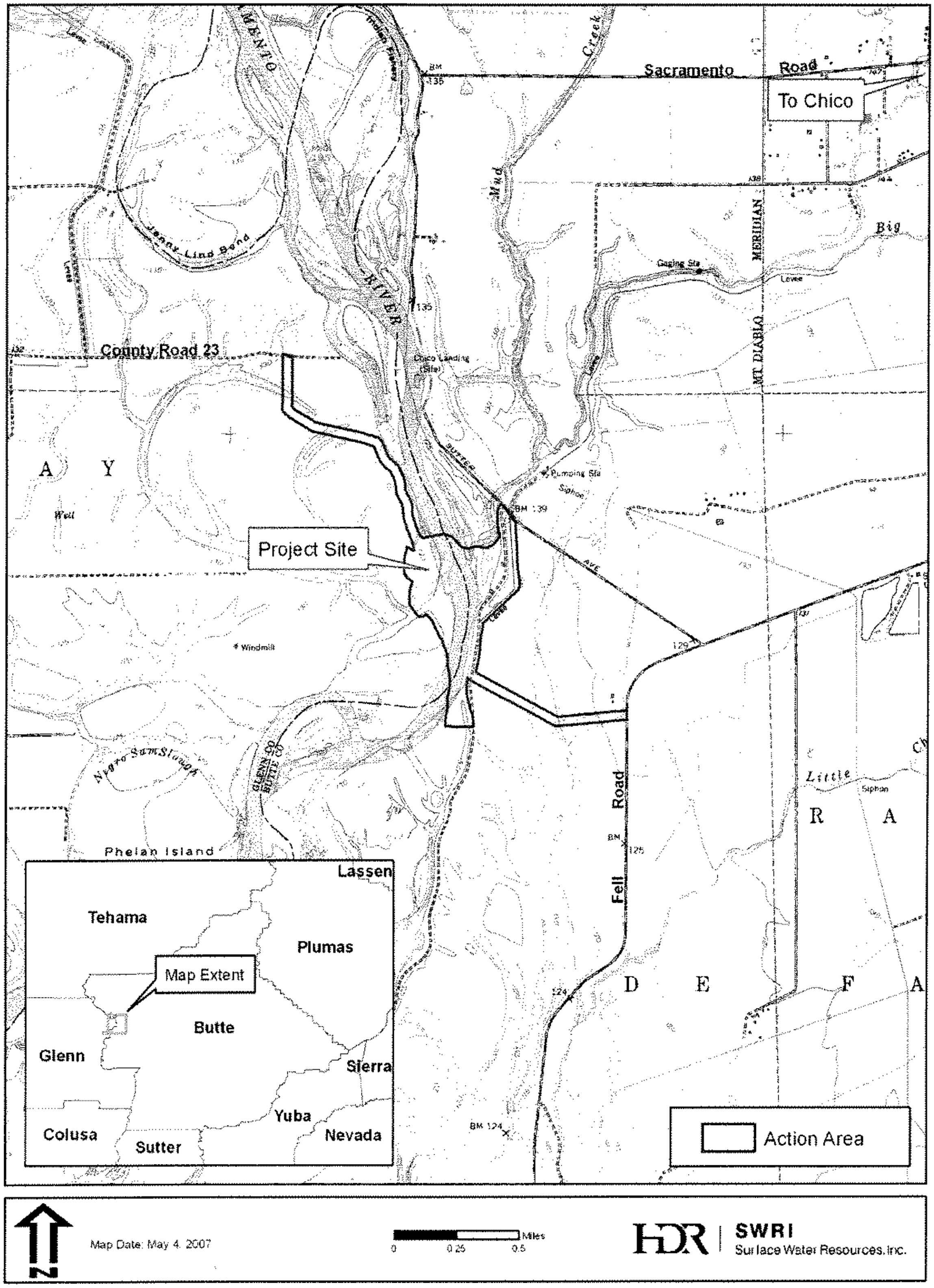



Figure 3. Location Map

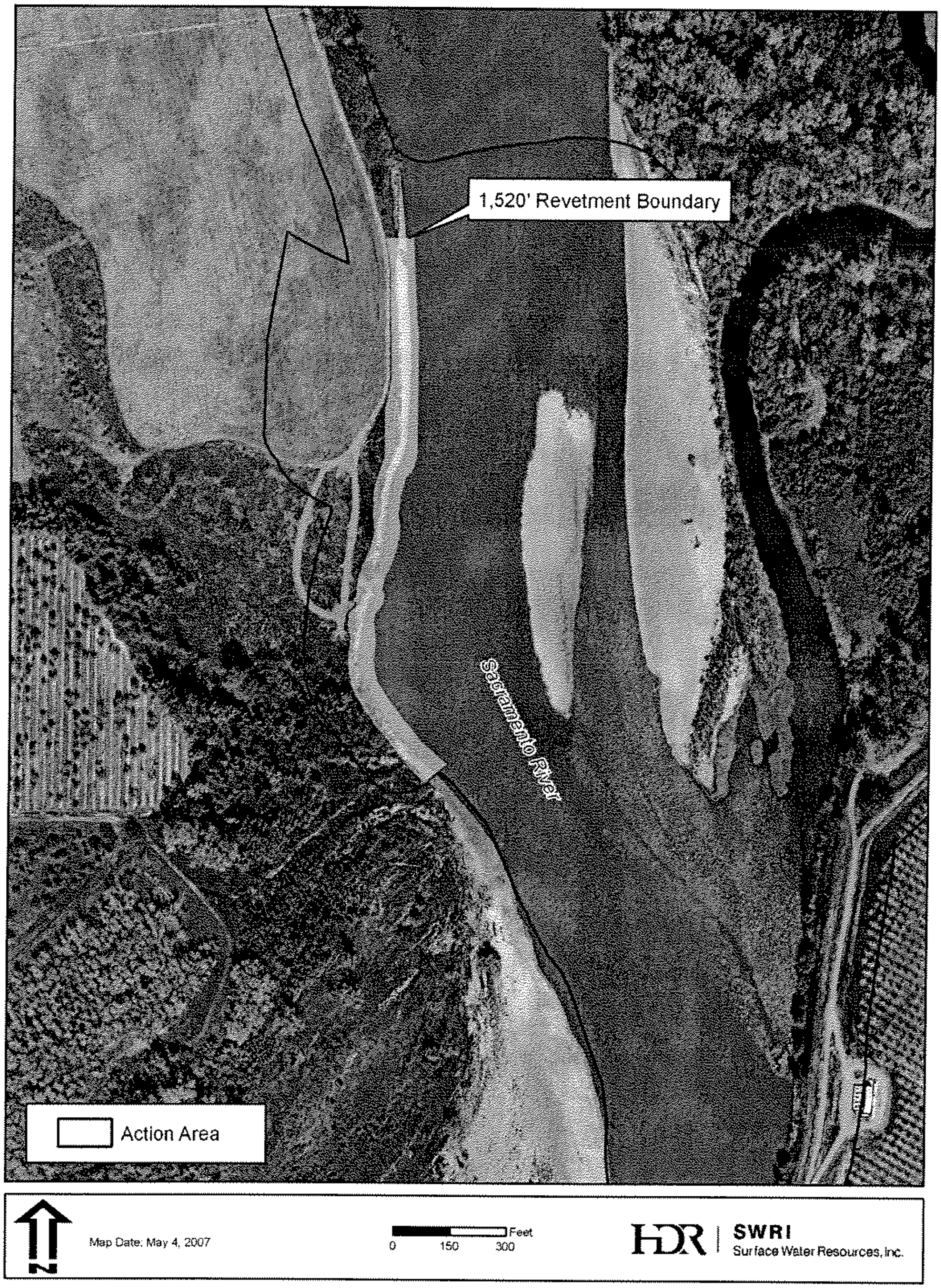



Figure 4. Stone Toe and Tree Revetment Plan View

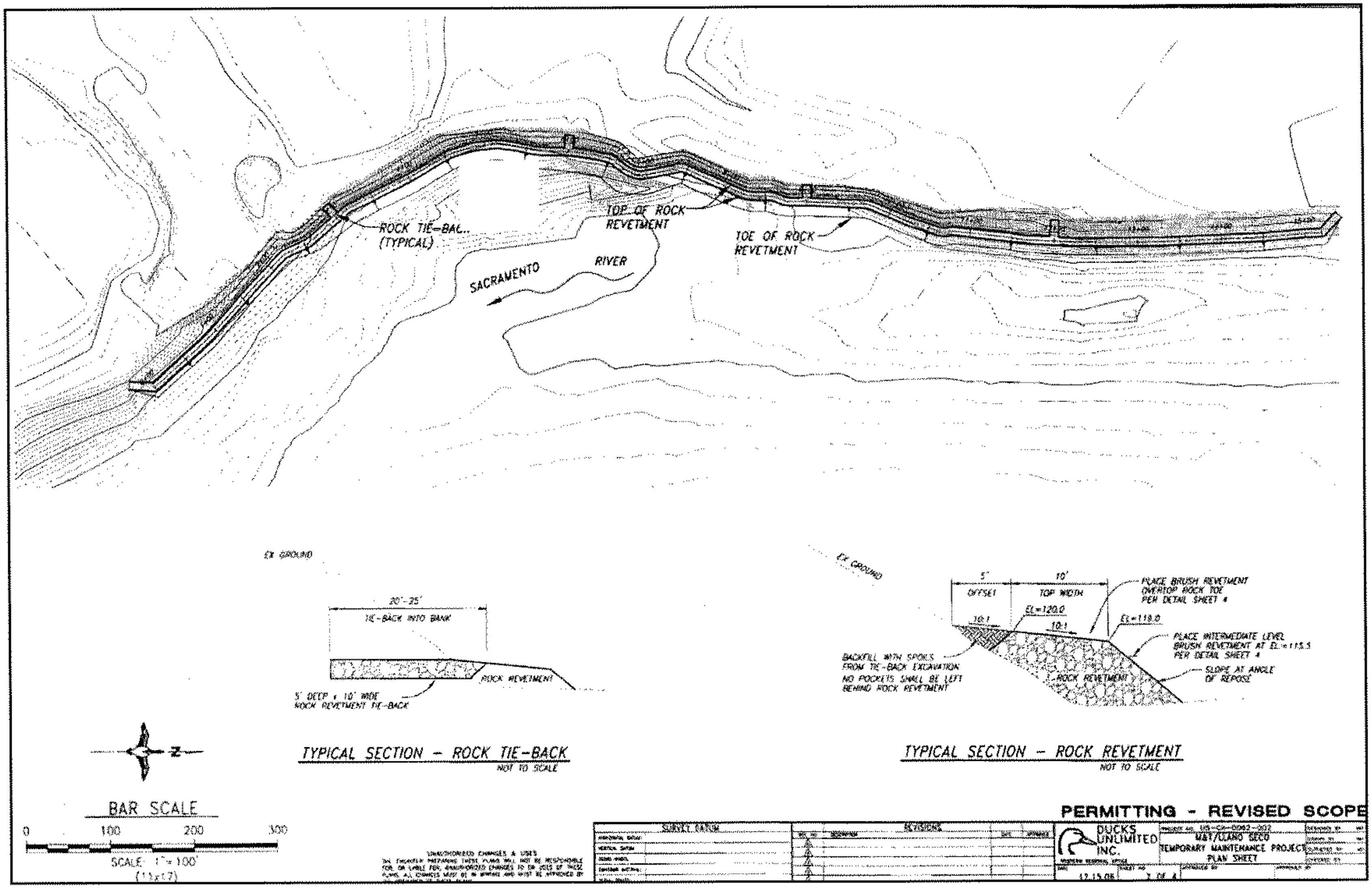



Figure 5. Engineering Detail of 1,520 Feet of Rock Toe Revetment on the West Bank of the Sacramento River.

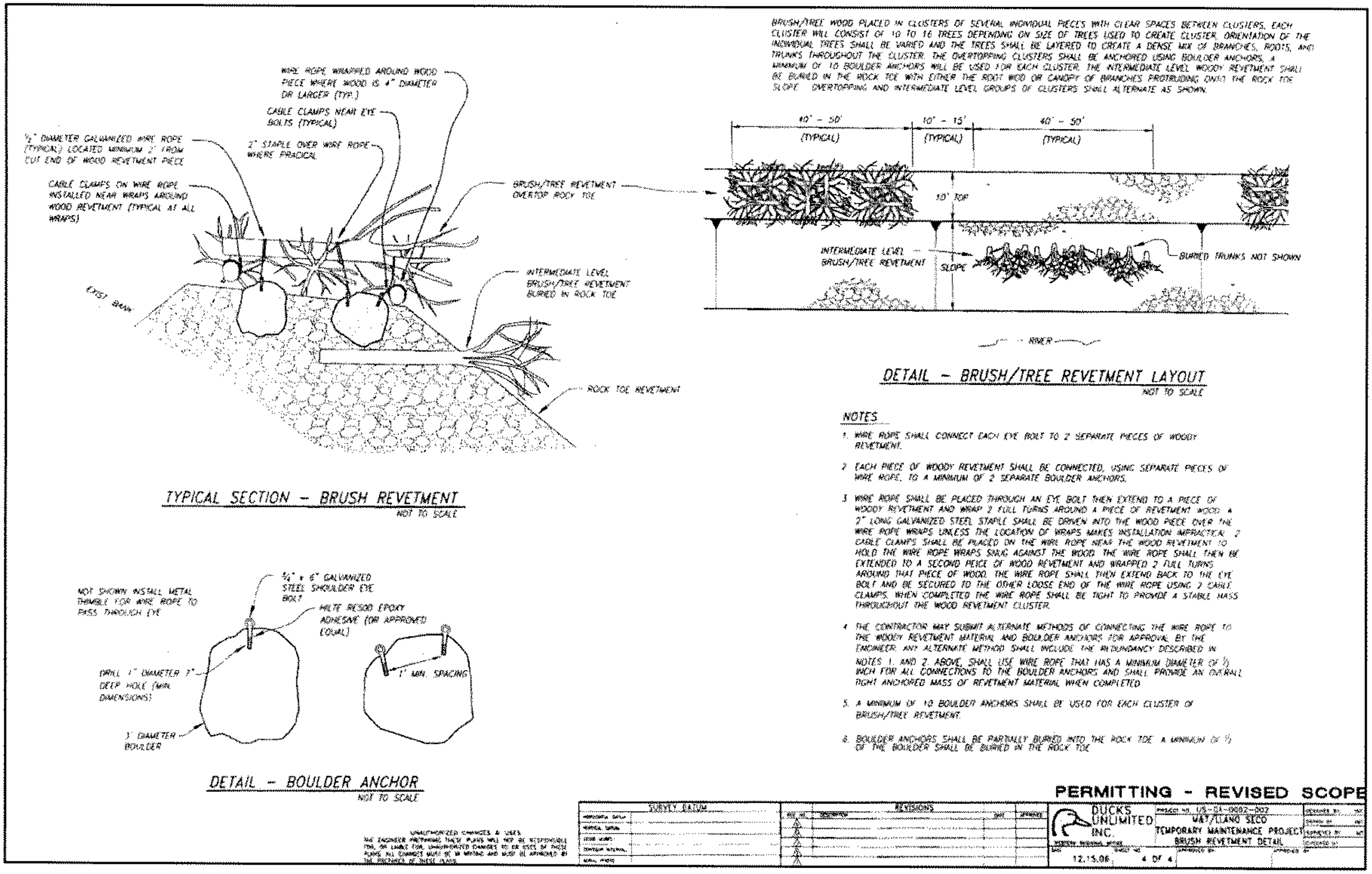



Figure 6. IWM Tie Down Details (modified from Northwest Hydraulics Consultants Inc. 2005)-Updated in 2/9 Meeting Materials

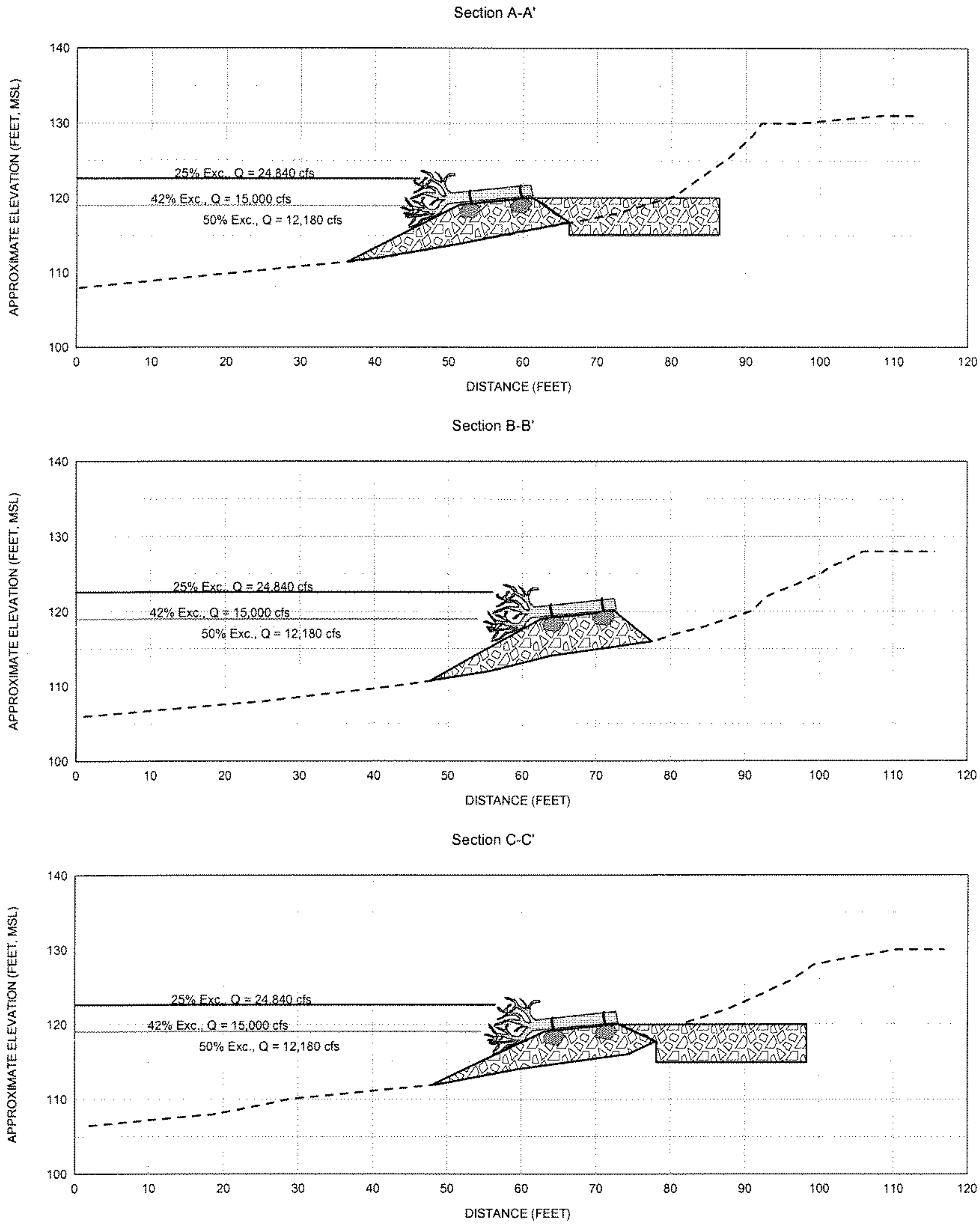



Figure 7. Typical Cross-Sections

* Cavity inboard of rock toe depicted in B-B' will be filled.

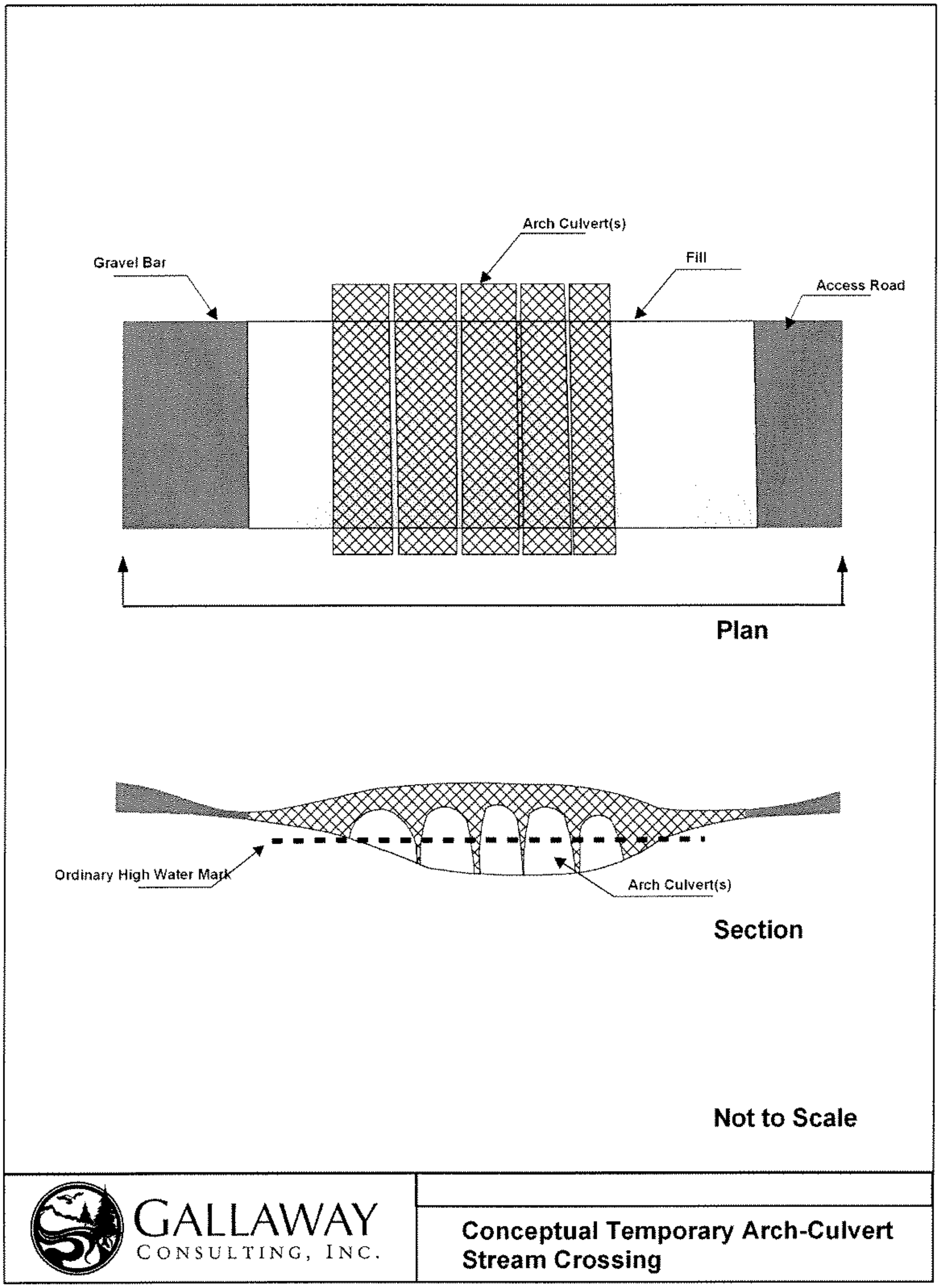



Figure 8. Big Chico Creek Culvert Crossing Concept

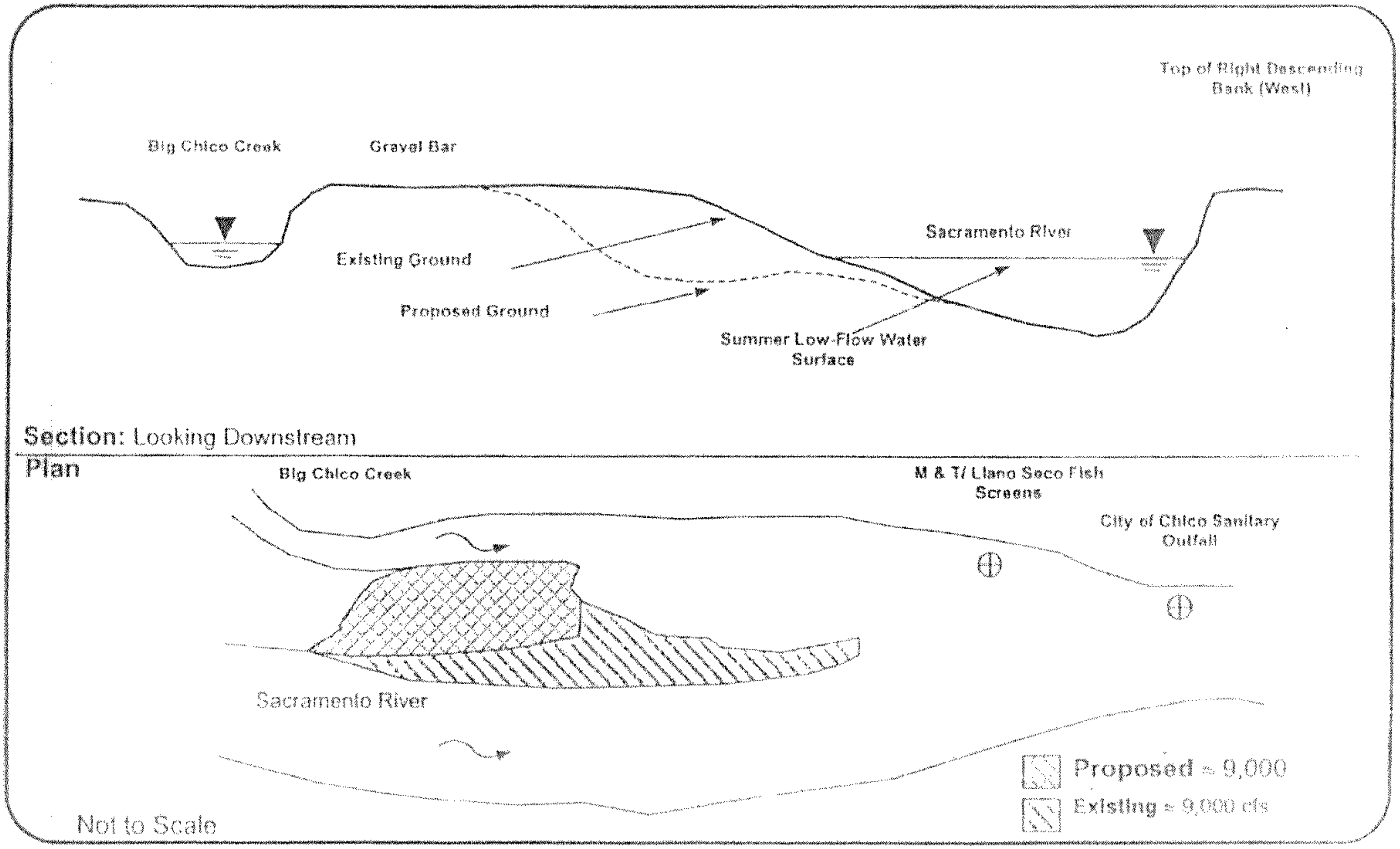



Figure 9. Concept Dredging Plan

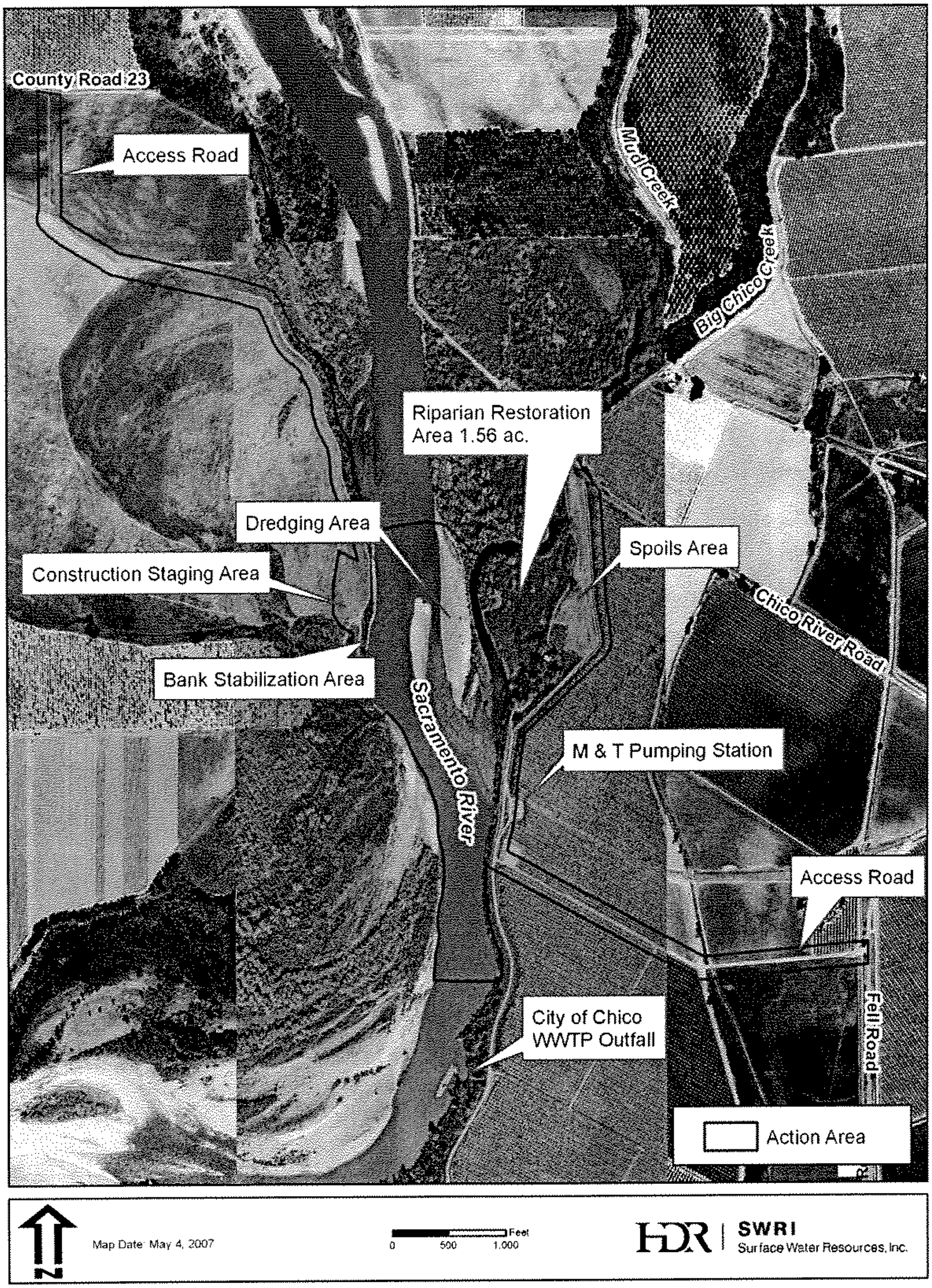



Figure 10. Proposed Action Area

## III. STATUS OF THE SPECIES AND CRITICAL HABITAT

The following Federally listed species evolutionary significant units (ESU) or distinct population segments (DPS) and designated critical habitat occurs in the action area and may be affected by the proposed project:

**Sacramento River winter-run Chinook salmon ESU** (*Oncorhynchus tshawytscha*)
endangered (June 28, 2005, 70 FR 37160)
**Sacramento River winter-run Chinook salmon designated critical habitat**
(June 16, 1993, 58 FR 33212)
**Central Valley spring-run Chinook salmon ESU** (*Oncorhynchus tshawytscha*)
threatened (June 28, 2005, 70 FR 37160)
**Central Valley spring-run Chinook salmon designated critical habitat**
(September 2, 2005, 70 FR 52488)
**Central Valley steelhead DPS** (*Oncorhynchus mykiss*)
threatened (December 22, 2005)
**Central Valley steelhead designated critical habitat**
(September 2, 2005, 70 FR 52488)
**Southern DPS of North American green sturgeon** (*Acipenser medirostris*)
threatened (April 7, 2006, 70 FR 17386)

### A. Species Life History, Population Dynamics, and Likelihood of Survival and Recovery

1. Chinook Salmon

Chinook salmon exhibit two generalized freshwater life history types (Healey 1991). "Stream-type" Chinook salmon, enter freshwater months before spawning and reside in freshwater for a year or more following emergence, whereas "ocean-type" Chinook salmon spawn soon after entering freshwater and migrate to the ocean as fry or parr within their first year. Spring-run Chinook salmon exhibit a stream-type life history. Adults enter freshwater in the spring, hold over summer, spawn in fall, and the juveniles typically spend a year or more in freshwater before emigrating. Winter-run Chinook salmon are somewhat anomalous in that they have characteristics of both stream- and ocean-type races (Healey 1991). Adults enter freshwater in winter or early spring, and delay spawning until spring or early summer (stream-type). However, juvenile winter-run Chinook salmon migrate to sea after only 4 to 7 months of river life (ocean-type). Adequate instream flows and cool water temperatures are more critical for the survival of Chinook salmon exhibiting a stream-type life history due to over-summering by adults and/or juveniles.

Chinook salmon typically mature between 2 and 6 years of age (Myers *et al.* 1998). Freshwater entry and spawning timing generally are thought to be related to local water temperature and flow regimes. Runs are designated on the basis of adult migration timing; however, distinct runs also differ in the degree of maturation at the time of river entry, thermal regime and flow characteristics of their spawning site, and the actual time of spawning (Myers *et al.* 1998). Both spring-run and winter-run Chinook salmon tend to enter freshwater as immature fish, migrate far upriver, and delay spawning for weeks or months. For comparison, fall-run Chinook salmon enter freshwater at an advanced stage of maturity, move rapidly to their spawning areas on the mainstem or lower tributaries of the rivers, and spawn within a few days or weeks of freshwater entry (Healey 1991).

Information on the migration rates of Chinook salmon in freshwater is scant and primarily comes from the Columbia River basin where information regarding migration behavior is needed to assess the effects of dams on travel times and passage (Matter *et al.* 2003). Keefer *et al.* (2004) found migration rates of Chinook salmon ranging from approximately 10 kilometers (km) per day to greater than 35 km per day and to be primarily correlated with date, and secondarily with discharge, year, and reach, in the Columbia River basin. Matter *et al.* (2003) documented migration rates of adult Chinook salmon ranging from 29 to 32 km per day in the Snake River. Adult Chinook salmon inserted with sonic tags and tracked throughout the Delta and lower Sacramento and San Joaquin rivers were observed exhibiting substantial upstream and downstream movement in a random fashion while migrating upstream (California Bay-Delta Authority (CALFED) 2001) several days at a time. Adult salmonids migrating upstream are assumed to make greater use of pool and mid-channel habitat than channel margins (Stillwater Sciences 2004), particularly larger salmon such as Chinook, as described by Hughes (2004). Adults are thought to exhibit crepuscular behavior during their upstream migrations; meaning that they primarily are active during twilight hours. Recent hydroacoustic monitoring conducted by LGL Environmental Research Associates showed peak upstream movement of adult Central Valley spring-run Chinook salmon in lower Mill Creek, a tributary to the Sacramento River, occurring the in the four hour period before sunrise and again after sunset.

Spawning Chinook salmon require clean, loose gravel in swift, relatively shallow riffles or along the margins of deeper runs, and suitable water temperatures, depths, and velocities for redd construction and adequate oxygenation of incubating eggs. Chinook salmon spawning typically occurs in gravel beds that are located at the tails of holding pools (USFWS 1995). Upon emergence, fry swim or are displaced downstream (Healey 1991). Similar to adult movement, juvenile salmonid downstream movement is crepuscular. Documents and data provided to NMFS in support of ESA section 10 research permit applications depicts that the daily migration of juveniles passing RBDD is highest in the four hour period prior to sunrise (Martin *et al.* 2001). Once started downstream, fry may continue downstream to the estuary and rear, or may take up residence in the stream for a period of time from weeks to a year (Healey 1991).

Fry then seek nearshore habitats containing beneficial aspects such as riparian vegetation and associated substrates important for providing aquatic and terrestrial invertebrates, predator avoidance, and slower velocities for resting (NMFS 1996). The benefits of shallow water habitats for salmonid rearing also have recently been realized as shallow water habitat has been found to be more productive than the main river channels, supporting higher growth rates, partially due to higher prey consumption rates, as well as favorable environmental temperatures (Sommer *et al.*

2001). Within the Delta, juvenile Chinook salmon forage in shallow areas with protective cover, such as tidally influenced sandy beaches and vegetated zones (Meyer 1979, Healey 1980). Cladocerans, copepods, amphipods, and larvae of diptera, as well as small arachnids and ants are common prey items (Kjelson *et al.* 1982, MacFarlane and Norton 2001, Sommer *et al.* 2001).

As juvenile Chinook salmon grow they move into deeper water with higher current velocities, but still seek shelter and velocity refugia to minimize energy expenditures (Healey 1991). Catches of juvenile salmon in the Sacramento River near West Sacramento by the USFWS (1997) exhibited larger juvenile captures in the main channel and smaller sized fry along the margins. When the channel of the river is greater than 9 to 10 feet in depth, juvenile salmon tend to inhabit the surface waters (Healey 1980). Stream flow and/or turbidity increases in the upper Sacramento River basin are thought to stimulate emigration (Kjelson *et al.* 1982, Brandes and McLain, 2001).

Juvenile Chinook salmon migration rates vary considerably presumably depending on the physiological stage of the juvenile and hydrologic conditions. Kjelson *et al.* (1982) found fry Chinook salmon to travel as fast as 30 kilometers (km) per day in the Sacramento River and Sommer *et al.* (2001) found rates ranging from approximately 0.5 miles up to more than 6 miles per day in the Yolo Bypass. As Chinook salmon begin the smoltification stage, they prefer to rear further downstream where ambient salinity is up to 1.5 to 2.5 parts per thousand (Healey 1980, Levy and Northcote 1981).

Within the estuarine habitat, juvenile Chinook salmon movements are dictated by the tidal cycles, following the rising tide into shallow water habitats from the deeper main channels, and returning to the main channels when the tide recedes (Levy and Northcote 1981, Healey 1991). Kjelson *et al.* (1982) reported that juvenile Chinook salmon demonstrated a diel migration pattern, orienting themselves to nearshore cover and structure during the day, but moving into more open, offshore waters at night. The fish also distributed themselves vertically in relation to ambient light. During the night, juveniles were distributed randomly in the water column, but would school up during the day into the upper 3 meters of the water column. Juvenile Chinook salmon were found to spend about 40 days migrating through the Sacramento-San Joaquin Delta to the mouth of San Francisco Bay and grew little in length or weight until they reached the Gulf of the Farallone Islands (MacFarlane and Norton 2001). Based on the mainly ocean-type life history observed (*i.e.*, fall-run Chinook salmon) MacFarlane and Norton (2001) concluded that unlike other salmonid populations in the Pacific Northwest, Central Valley Chinook salmon show little estuarine dependence and may benefit from expedited ocean entry.

a. *Sacramento River Winter-run Chinook Salmon*

Sacramento River winter-run Chinook salmon originally were listed as threatened in August 1989, under emergency provisions of the Endangered Species Act (ESA), and formally listed as threatened in November 1990 (55 FR 46515). The ESU consists of only one population that is confined to the upper Sacramento River in California's Central Valley. The ESU was reclassified as endangered on January 4, 1994 (59 FR 440), due to increased variability of run sizes, expected weak returns as a result of two small year classes in 1991 and 1993, and a 99 percent decline between 1966 and 1991. NMFS reaffirmed the listing of Sacramento River winter-run Chinook salmon as endangered on June 28, 2005 (70 FR 37160). The Livingston Stone National Fish Hatchery population has been included in the listed Sacramento River winter-run Chinook salmon population as of June 28, 2005 (70 FR 37160). NMFS designated critical habitat for winter-run Chinook salmon on June 16, 1993 (58 FR 33212).

Sacramento River winter-run Chinook salmon adults enter the Sacramento River basin between December and July; the peak occurring in March (Table 1; Yoshiyama *et al.* 1998, Moyle 2002). Spawning occurs primarily from mid-April to mid-August, with the peak activity occurring in May and June in the Sacramento River reach between Keswick Dam and Red Bluff Diversion Dam (RBDD) (Vogel and Marine 1991). The majority of Sacramento River winter-run Chinook salmon spawners are 3 years old.

Sacramento River winter-run Chinook salmon fry begin to emerge from the gravel in late June to early July and continue through October (Fisher 1994), with emergence generally occurring at night. Post-emergent fry disperse to the margins of the river, seeking out shallow waters with slower currents, finer sediments, and bank cover such as overhanging and submerged vegetation, root wads, and fallen woody debris, and begin feeding on small insects and crustaceans.

Emigration of juvenile Sacramento River winter-run Chinook salmon past RBDD may begin as early as mid July, typically peaks in September, and can continue through March in dry years (Vogel and Marine 1991, NMFS 1997). From 1995 to 1999, all Sacramento River winter-run Chinook salmon outmigrating as fry passed RBDD by October, and all outmigrating pre-smolts and smolts passed RBDD by March (Martin *et al.* 2001). Juvenile Sacramento River winter-run Chinook salmon occur in the Delta primarily from November through early May based on data collected from trawls in the Sacramento River at West Sacramento (RM 57) (USFWS 2001). The timing of migration may vary somewhat due to changes in river flows, dam operations, and water year type. Winter-run Chinook salmon juveniles remain in the Delta until they reach a fork length of approximately 118 millimeters (mm) and are from 5 to 10 months of age, and then begin emigrating to the ocean as early as November and continuing through May (Fisher 1994, Myers *et al.* 1998).

Historical Sacramento River winter-run Chinook salmon population estimates, which included males and females, were as high as near 100,000 fish in the 1960s, but declined to under 200 fish in the 1990s (Good *et al.* 2005). Population estimates in 2003 (8,218), 2004 (7,701), and 2005 (15,730) show a recent increase in the population size (California Department of Fish and Game [CDFG] Grandtab, February 2005, letter titled "Winter-run Chinook Salmon Escapement Estimates for 2005" from CDFG to NMFS, January 13, 2006) and a 3-year average of 10,550. The 2005 run was the highest since the listing. Overall, abundance measures suggest that the abundance is increasing (Good *et al.* 2005). Two current methods are utilized to estimate the juvenile production of Sacramento River winter-run Chinook salmon: the Juvenile Production Estimate (JPE) method, and the Juvenile Production Index (JPI) method (Gaines and Poytress

2004). Gaines and Poytress (2004) estimated the juvenile population of Sacramento River winter-run Chinook salmon exiting the upper Sacramento River at RBDD to be 3,707,916 juveniles per year using the JPI method between the years 1995 and 2003 (excluding 2000 and 2001). Using the JPE method, they estimated an average of 3,857,036 juveniles exiting the upper Sacramento River at RBDD between the years of 1996 and 2003 (Gaines and Poytress 2004). Averaging these 2 estimates yields an estimated population size of 3,782,476.

Based on the RBDD counts, the population has been growing rapidly since the 1990s with positive short-term trends. An age-structured density-independent model of spawning escapement by Botsford and Brittnacker in 1998 (as referenced in Good *et al.* 2005) assessing the viability of Sacramento River winter-run Chinook salmon found the species was certain to fall below the quasi-extinction threshold of 3 consecutive spawning runs with fewer than 50 females (Good *et al.* 2005). Lindley *et al.* (2003) assessed the viability of the population using a Bayesian model based on spawning escapement that allowed for density dependence and a change in population growth rate in response to conservation measures found a biologically significant expected quasi-extinction probability of 28 percent. Although the status of the Sacramento River winter-run Chinook salmon population is improving, there is only one population, and it depends on cold-water releases from Shasta Dam, which could be vulnerable to a prolonged drought (Good *et al.* 2005).

Lindley *et al.* (2007), in their framework for assessing the viability of Chinook salmon and steelhead in the Sacramento-San Joaquin basin, concluded that the population of winter-run Chinook salmon that spawns below Keswick dam satisfies low-risk criteria for population size and population decline, but increasing hatchery influence is a concern that puts the population at a moderate risk of extinction. Furthermore, Lindley *et al.* (2007) point out that an ESU represented by a single population at moderate risk, is at a high risk of extinction over the long term.

b. *Central Valley Spring-run Chinook Salmon*

NMFS listed the Central Valley spring-run Chinook salmon (CV spring-run Chinook salmon) ESU as threatened on September 16, 1999 (64 FR 50394). In June 2004, NMFS proposed that CV spring-run Chinook salmon remain listed as threatened (69 FR 33102). This proposal was based on the recognition that although CV spring-run Chinook salmon productivity trends are positive, the ESU continues to face risks from having a limited number of remaining populations (*i.e.*, 3 existing populations from an estimated 17 historical populations), a limited geographic distribution, and potential hybridization with Feather River Hatchery (FRH) spring-run Chinook salmon, which until recently were not included in the ESU and are genetically divergent from other populations in Mill, Deer, and Butte Creeks. On June 28, 2005, after reviewing the best available scientific and commercial information, NMFS issued its final decision to retain the status of CV spring-run Chinook salmon as threatened (70 FR 37160). This decision also included the FRH spring-run Chinook salmon population as part of the CV spring-run Chinook salmon ESU. Critical habitat was designated for CV spring-run Chinook salmon on September 2, 2005 (70 FR 52488).

Adult CV spring-run Chinook salmon leave the ocean to begin their upstream migration in late January and early February (CDFG 1998) and enter the Sacramento River between March and September, primarily in May and June (Table 2; Yoshiyama *et al.* 1998, Moyle 2002). Lindley *et al.* (2006a) indicates adult CV spring-run Chinook salmon enter native tributaries from the Sacramento River primarily between mid April and mid June. Typically, spring-run Chinook salmon utilize mid- to high-elevation streams that provide appropriate temperatures and sufficient flow, cover, and pool depth to allow over-summering while conserving energy and allowing their gonadal tissue to mature (Yoshiyama *et al.* 1998).

Spring-run Chinook salmon fry emerge from the gravel from November to March (Moyle 2002) and the emigration timing is highly variable, as they may migrate downstream as young-of-the-year (YOY) or as juveniles or yearlings. The modal size of fry migrants at approximately 40 mm between December and April in Mill, Butte, and Deer Creeks reflects a prolonged emergence of fry from the gravel (Lindley *et al.* 2006a). Studies in Butte Creek (Ward *et al.* 2002, 2003, McReynolds *et al.* 2005) found the majority of CV spring-run Chinook salmon migrants to be fry occurring primarily during December, January and February; and that these movements appeared to be influenced by flow. Small numbers of CV spring-run Chinook salmon remained in Butte Creek to rear and migrated as yearlings later in the spring. Juvenile emigration patterns in Mill and Deer Creeks are very similar to patterns observed in Butte Creek, with the exception that Mill and Deer Creek juveniles typically exhibit a later young-of-the-year (YOY) migration and an earlier yearling migration (Lindley *et al.* 2006a).

Once juveniles emerge from the gravel they initially seek areas of shallow water and low velocities while they finish absorbing the yolk sac (Moyle 2002). Many also will disperse downstream during high-flow events. As is the case in other salmonids, there is a shift in microhabitat use by juveniles to deeper faster water as they grow. Microhabitat use can be influenced by the presence of predators which can force fish to select areas of heavy cover and suppress foraging in open areas (Moyle 2002). Peak movement of juvenile CV spring-run Chinook salmon in the Sacramento River at Knights Landing occurs in December, and again in March and April. However, juveniles also are observed between November and the end of May (Snider and Titus 2000).

On the Feather River, significant numbers of spring-run Chinook salmon, as identified by run timing, return to the FRH. In 2002, the FRH reported 4,189 returning spring-run Chinook salmon, which is 22 percent below the 10-year average of 4,727 fish. However, coded-wire tag (CWT) information from these hatchery returns indicates substantial introgression has occurred between fall-run and spring-run Chinook salmon populations within the Feather River system due to hatchery practices. Because Chinook salmon are not temporally separated in the hatchery, spring-run and fall-run Chinook salmon have been spawned together, thus compromising the genetic integrity of the spring-run Chinook salmon stock. The number of naturally-spawning spring-run Chinook salmon in the Feather River has been estimated only periodically since the 1960s, with estimates ranging from 2 fish in 1978 to 2,908 in 1964. However, the genetic integrity of this population is questionable because of the significant temporal and spatial overlap between spawning populations of spring-run and fall-run Chinook salmon (Good *et al.* 2005). For the reasons discussed above, the Feather River spring-run Chinook population numbers are not included in the following discussion of ESU abundance.

The CV spring-run Chinook salmon ESU has displayed broad fluctuations in adult abundance, ranging from 1,403 in 1993 to 25,890 in 1982. The average abundance for the ESU was 12,590 for the period of 1969 to 1979, 13,334 for the period of 1980 to 1990, 6,554 from 1991 to 2001, and 16,349 between 2002 and 2005 (for the purposes of this biological opinion, the average adult population is assumed to be 16,349 until new information is available. Sacramento River tributary populations in Mill, Deer, and Butte Creeks are probably the best trend indicators for the Central Valley spring-run Chinook ESU as a whole because these streams contain the primary independent populations with the ESU. Generally, these streams have shown a positive escapement trend since 1991. Escapement numbers are dominated by Butte Creek returns, which have averaged over 7,000 fish since 1995. During this same period, adult returns on Mill Creek have averaged 778 fish, and 1,463 fish on Deer Creek. Although recent trends are positive, annual abundance estimates display a high level of fluctuation, and the overall number of CV spring-run Chinook salmon remains well below estimates of historic abundance. Additionally, in 2003, high water temperatures, high fish densities, and an outbreak of Columnaris Disease (*Flexibacter Columnaris*) and Ichthyophthiriasis (*Ichthyophthirius multifiis*) contributed to the pre-spawning mortality of an estimated 11,231 adult spring-run Chinook salmon in Butte Creek.

Lindley *et al.* (2007) concluded that Butte and Deer Creek fish are at low risk of extinction, satisfying viability criteria for population size, decline/growth rate, hatchery influence, and catastrophe. The Mill Creek population is at a low to moderate risk, satisfying some, but not all viability criteria. Lindley *et al.* (2007) found Feather and Yuba River populations as data deficient and did not assess their viability. However, because the existing CV spring-run Chinook salmon populations are spatially confined to relatively few remaining streams in only one of four historic diversity groups, the ESU remains vulnerable to catastrophic disturbance, and it therefore remains at a moderate to high risk of extinction.

2. <u>Central Valley Steelhead</u>

Central Valley steelhead (CV steelhead) was originally listed as threatened on March 19, 1998 (63 FR 13347). This DPS consists of steelhead populations in the Sacramento and San Joaquin River basins in California's Central Valley. In June 2004, NMFS proposed that CV spring-run Chinook salmon remain listed as threatened (69 FR 33102). On June 28, 2005, after reviewing the best available scientific and commercial information, NMFS issued its final decision to retain the status of CV steelhead as threatened (70 FR 37160). This decision also included the Coleman National Fish Hatchery and FRH steelhead populations. These populations were previously included in the DPS but were not deemed essential for conservation and thus not part of the listed steelhead population. Critical habitat was designated for CV steelhead on September 2, 2005 (70 FR 52488).

Steelhead can be divided into two life history types, summer-run steelhead and winter-run steelhead, based on their state of sexual maturity at the time of river entry and the duration of their spawning migration, stream-maturing and ocean-maturing. Only winter steelhead currently are found in Central Valley rivers and streams (McEwan and Jackson 1996), although there are indications that summer steelhead were present in the Sacramento river system prior to the commencement of large-scale dam construction in the 1940s (Interagency Ecological Program (IEP) Steelhead Project Work Team 1999). At present, summer steelhead are found only in North Coast drainages, mostly in tributaries of the Eel, Klamath, and Trinity River systems (McEwan and Jackson 1996).

CV steelhead generally leave the ocean from August through April (Busby *et al.* 1996), and spawn from December through April with peaks from January though March in small streams and tributaries where cool, well oxygenated water is available year-round (Hallock *et al.* 1961, McEwan and Jackson 1996) (Table 3). Timing of upstream migration is correlated with higher flow events, such as freshets or sand bar breaches, and associated lower water temperatures. Unlike Pacific salmon, steelhead are iteroparous, or capable of spawning more than once before death (Busby *et al.* 1996). However, it is rare for steelhead to spawn more than twice before dying; most that do so are females (Busby *et al.* 1996). Iteroparity is more common among southern steelhead populations than northern populations (Busby *et al.* 1996). Although one-time spawners are the great majority, Shapolov and Taft (1954) reported that repeat spawners are relatively numerous (17.2 percent) in California streams.

Spawning occurs during winter and spring months. The length of time it takes for eggs to hatch depends mostly on water temperature. Hatching of steelhead eggs in hatcheries takes about 30 days at 51 °F. Fry emerge from the gravel usually about four to six weeks after hatching, but factors such as redd depth, gravel size, siltation, and temperature can speed or retard this time (Shapovalov and Taft 1954). Newly emerged fry move to the shallow, protected areas associated with the stream margin (McEwan and Jackson 1996) and they soon move to other areas of the stream and establish feeding locations, which they defend (Shapovalov and Taft 1954).

Steelhead rearing during the summer takes place primarily in higher velocity areas in pools, although young-of-the-year also are abundant in glides and riffles. Productive steelhead habitat is characterized by complexity, primarily in the form of large and small woody debris. Cover is an important habitat component for juvenile steelhead both as velocity refugia and as a means of avoiding predation (Meehan and Bjornn 1991).

Juvenile steelhead emigrate episodically from natal streams during fall, winter, and spring high flows. Emigrating CV steelhead use the lower reaches of the Sacramento River and the Delta for rearing and as a migration corridor to the ocean. Juvenile CV steelhead feed mostly on drifting aquatic organisms and terrestrial insects and will also take active bottom invertebrates (Moyle 2002).

Some may utilize tidal marsh areas, non-tidal freshwater marshes, and other shallow water areas in the Delta as rearing areas for short periods prior to their final emigration to the sea. Hallock *et al.* (1961) found that juvenile steelhead in the Sacramento River basin migrate downstream during most months of the year, but the peak period of emigration occurred in the spring, with a much smaller peak in the fall. Nobriga and Cadrett (2003) also have verified these temporal findings based on analysis of captures at Chipps Island, Suisun Bay.

Historic CV steelhead run sizes are difficult to estimate given the paucity of data, but may have approached 1 to 2 million adults annually (McEwan 2001). By the early 1960s the steelhead run size had declined to about 40,000 adults (McEwan 2001). Over the past 30 years, the naturally-spawned steelhead populations in the upper Sacramento River have declined substantially. Hallock *et al.* (1961) estimated an average of 20,540 adult steelhead through the 1960s in the Sacramento River, upstream of the Feather River. Steelhead counts at the RBDD declined from an average of 11,187 for the period of 1967 to 1977, to an average of approximately 2,000 through the early 1990s, with an estimated total annual run size for the entire Sacramento-San Joaquin system, based on RBDD counts, to be no more than 10,000 adults (McEwan and Jackson 1996, McEwan 2001). Steelhead escapement surveys at RBDD ended in 1993 due to changes in dam operations.

Recent estimates from trawling data in the Delta indicate that approximately 100,000 to 300,000 (mean 200,000) smolts emigrate to the ocean per year representing approximately 3,600 female CV steelhead spawners in the Central Valley basin (Good *et al.* 2005). This can be compared with McEwan's (2001) estimate of one million to two million spawners before 1850, and 40,000 spawners in the 1960s.

Existing wild steelhead stocks in the Central Valley are mostly confined to the upper Sacramento River and its tributaries, including Antelope, Deer, and Mill Creeks and the Yuba River. Populations may exist in Big Chico and Butte Creeks and a few wild steelhead are produced in the American and Feather Rivers (McEwan and Jackson 1996). Recent snorkel surveys (1999 to 2002) indicate that steelhead are present in Clear Creek (J. Newton, USFWS, pers. comm. 2002, as reported in Good *et al.* 2005). Because of the large resident *O. mykiss* population in Clear Creek, steelhead spawner abundance has not been estimated.

Until recently, CV steelhead were thought to be extirpated from the San Joaquin River system. Recent monitoring has detected small self-sustaining populations of steelhead in the Stanislaus, Mokelumne, and Calaveras rivers, and other streams previously thought to be devoid of steelhead (McEwan 2001). On the Stanislaus River, steelhead smolts have been captured in rotary screw traps at Caswell State Park and Oakdale each year since 1995 (S.P. Cramer and Associates Inc. 2000, 2001).

It is possible that naturally-spawning populations exist in many other streams but are undetected due to lack of monitoring programs (IEP Steelhead Project Work Team 1999). Incidental catches and observations of steelhead juveniles also have occurred on the Tuolumne and Merced Rivers during fall-run Chinook salmon monitoring activities, indicating that steelhead are widespread, throughout accessible streams and rivers in the Central Valley (Good *et al.* 2005). CDFG staff has prepared juvenile migrant CV steelhead catch summaries on the San Joaquin River near Mossdale representing migrants from the Stanislaus, Tuolumne, and Merced Rivers. Based on trawl recoveries at Mossdale between 1988 and 2002, as well as rotary screw trap efforts in all three tributaries, CDFG staff stated that it is "clear from this data that rainbow trout do occur in all the tributaries as migrants and that the vast majority of them occur on the Stanislaus River" (Letter from Dean Marston, CDFG, to Madelyn Martinez, NMFS, January 9, 2003). The documented returns on the order of single fish in these tributaries suggest that existing populations of CV steelhead on the Tuolumne, Merced, and lower San Joaquin Rivers are severely depressed.

Lindley *et al.* (2006) indicated that prior population census estimates completed in the 1990s found the CV steelhead spawning population above RBDD had a fairly strong negative population growth rate and small population size. Good *et al.* (2005) indicated the decline was continuing as evidenced by new information (Chipps Island trawl data). CV steelhead populations generally show a continuing decline, an overall low abundance, and fluctuating return rates. The future of CV steelhead is uncertain due to limited data concerning their status. However, Lindlely *et al.* (2007), citing evidence presented by Yoshiyama *et al.* (1996); McEwan (2001); and Lindley *et al.* (2006), concluded that there is sufficient evidence to suggest that the ESU is at moderate to high risk of extinction.

3. <u>Southern Distinct Population Segment of North American Green Sturgeon</u>

The southern DPS of North American green sturgeon was listed as threatened on April 7, 2006, (70 FR 17386) and includes the North American green sturgeon population spawning in the Sacramento River and utilizing the Sacramento River, the Delta, and the San Francisco Estuary.

North American green sturgeon are widely distributed along the Pacific Coast and have been documented offshore from Ensenada Mexico to the Bering Sea and found in rivers from British Columbia to the Sacramento River (Moyle 2002). As is the case for most sturgeon, North American green sturgeon are anadromous; however, they are the most marine-oriented of the sturgeon species (Moyle 2002). In North America, spawning populations of the anadromous green sturgeon currently are found in only three river systems, the Sacramento and Klamath Rivers in California and the Rogue River in southern Oregon.

Two green sturgeon DPSs were identified based on evidence of spawning site fidelity (indicating multiple DPS tendencies), and on the preliminary genetic evidence that indicates differences at least between the Klamath River and San Pablo Bay samples (Adams *et al.* 2002). The Northern DPS includes all green sturgeon populations starting with the Eel River and extending northward. The southern DPS would include all green sturgeon populations south of the Eel River with the only known spawning population being in the Sacramento River.

The southern DPS of North American green sturgeon life cycle can be broken into four distinct phases based on developmental stage and habitat use: (1) adult females greater than or equal to 13 years of age and males greater than or equal to 9 years of age, (2) larvae and post-larvae less than 10 months of age, (3) juveniles less than or equal to 3 years of age, and (4) coastal migrant females between 3 and 13, and males between 3 and 9 years of age (Nakamoto *et al.* 1995, Jeff McLain, NMFS, pers. comm., 2006).

New information regarding the migration and habitat use of the southern DPS of North American green sturgeon has emerged. Lindley (2006c) presents preliminary results of large-scale green sturgeon migration studies. Lindley's analysis verified past population structure delineations based on genetic work and found frequent large-scale migrations of green sturgeon along the Pacific Coast. It appears North American green sturgeon migrate considerable distances up the Pacific Coast into several bays and estuaries, particularly the Columbia River estuary. This information also agrees with the results of green sturgeon tagging studies completed by CDFG where they tagged a total of 233 green sturgeons in the San Pablo Estuary between 1954 and 2001. A total of 17 tagged fish were recovered: 3 in the Sacramento-San Joaquin Estuary, 2 in the Pacific Ocean off of California, and 12 from commercial fisheries off of Oregon and Washington. Eight of the 12 recoveries were in the Columbia Estuary (CDFG 2002).

Kelley *et al.* (2006) indicated that green sturgeon enter the San Francisco Estuary during the spring and remain until autumn. The authors studied the movement of adults in the San Francisco Estuary and found them to make significant long-distance movements with distinct directionality. The movements were not found to be related to salinity, current, or temperature and the authors surmised they are related to resource availability (Kelley *et al.* 2006). The majority of green sturgeon in the Rogue River emigrated from freshwater habitat in December after water temperatures dropped (Erickson *et al.* 2002). Green sturgeon were most often found at depths greater than 5 meters with low or no current during summer and autumn months (Erickson *et al.* 2002). The authors surmised that this holding in deep pools was to conserve energy and utilize abundant food resources. Based on captures of adult green sturgeon in holding pools on the Sacramento River above the GCID diversion (RM 205) and the documented presence of adults in the Sacramento River during the spring and summer months and the presence of larval green sturgeon in late summer in the lower Sacramento River indicating spawning ocurrence, it appears adult green sturgeon could possibly utilize a variety of freshwater and brackish habitats for up to nine months of the year (Ray Beamesderfer, S.P. Cramer & Associates, Inc., pers. comm. 2006).

Adult green sturgeon are believed to feed primarily upon benthic invertebrates such as clams, mysid and grass shrimp, and amphipods (Radtke 1966, Adams *et al.* 2002, Jeffrey Stuart, NMFS, pers. comm. 2006). Adult sturgeon caught in Washington State waters were found to have fed on Pacific sand lance (*Ammodytes hexapterus*) and callianassid shrimp (Moyle *et al.* 1992).

Based on the distribution of sturgeon eggs, larva, and juveniles in the Sacramento River, CDFG (2002) indicated that southern DPS of green sturgeon spawn in late spring and early summer above Hamilton City possibly to Keswick Dam. Adult green sturgeon are believed to spawn every 3 to 5 years and reach sexual maturity only after several years of growth (*i.e.*, 10 to 15 years based on sympatric white sturgeon sexual maturity (CDFG 2002). Adult female green sturgeon produce between 60,000 and 140,000 eggs each reproductive cycle, depending on body size, with a mean egg diameter of 4.3 mm (Moyle *et al.* 1992, Van Eenennaam *et al.* 2001). Southern DPS Green sturgeon adults begin their upstream spawning migrations into the San Francisco Bay in March, reach Knights Landing during April, and spawn between March and July (Heublein *et al.* 2006). Peak spawning is believed to occur between April and June (Table 4) and thought to occur in deep turbulent pools (Adams *et al.* 2002). Substrate is likely large cobble but can range from clean sand to bedrock (USFWS 2002). Newly hatched green sturgeon are approximately 12.5 to 14.5 mm in length. According to Heublein (2006) all adults leave the Sacramento River prior to September 1.

After approximately 10 days, larvae begin feeding, growing rapidly, and young green sturgeon appear to rear for the first 1 to 2 months in the Sacramento River between Keswick Dam and Hamilton City (CDFG 2002). Juvenile green sturgeon first appear in USFWS sampling efforts at RBDD in June and July at lengths ranging from 24 to 31 mm fork length (CDFG 2002, USFWS 2002). The mean yearly total length of post-larval green sturgeon captured in rotary screw traps at the RBDD ranged from 26 mm to 34 mm between 1995 and 2000 indicating they are approximately 2 weeks old. The mean yearly total length of post-larval green sturgeon captured in the GCID rotary screw trap, approximatley 30 miles downstream of RBDD ranged from 33 mm to 44 mm between 1997 and 2005 (CDFG, unpublished data) indicating they are approximately 3 weeks old (Van Eenennaam *et al.* 2001).

Green sturgeon larvae do not exhibit the initial pelagic swim-up behavior characteristic of other *Acipenseridae.* They are strongly oriented to the bottom and exhibit nocturnal activity patterns. Under laboratory conditions, green sturgeon larvae cling to the bottom during the day, and move into the water column at night (Van Eenennaam *et al.* 2001). After six days, the larvae exhibit nocturnal swim-up activity (Deng *et al.* 2002) and nocturnal downstream migrational movements (Kynard *et al.* 2005). Juvenile green sturgeon continue to exhibit nocturnal behavioral beyond the metamorphosis from larvae to juvenile stages. Kynard *et al.*'s (2005) laboratory studies indicated that juvenile fish continued to migrate downstream at night for the first six months of life. When ambient water temperatures reached 46 °F, downstream migrational behavior diminished and holding behavior increased. This data suggests that 9-to 10-month-old fish would hold over in their natal rivers during the ensuing winter following hatching, but at a location downstream of their spawning grounds. Juvenile green sturgeon have been salvaged at the Harvey O. Banks Pumping Plant and the John E. Skinner Fish Facility (Fish Facilities) in the South Delta, and captured in trawling studies by the CDFG during all months of the year (CDFG 2002). The majority of these fish were between 200 and 500 mm indicating they were from 2 to 3 years of age based on Klamath River age distribution work by Nakamoto *et al.* (1995). The lack of a significant proportion of juveniles smaller than approximately 200 mm in Delta captures indicates juvenile southern DPS North American green sturgeon likely hold in the mainstem Sacramento River as suggested by Kyndard *et al.* (2005).

Population abundance information concerning the southern DPS green sturgeon is described in the NMFS status reviews (Adams *et al.* 2002, NMFS 2005a). Limited population abundance information comes from incidental captures of North American green sturgeon from the white sturgeon monitoring program by the CDFG sturgeon tagging program (CDFG 2002). By comparing ratios of white sturgeon to green sturgeon captures, CDFG provides estimates of adult and sub-adult North American green sturgeon abundance. Estimated abundance between 1954 and 2001 ranged from 175 fish to more than 8,000 per year and averaged 1,509 fish per year. Unfortunately, there are many biases and errors associated with these data, and CDFG does not consider these estimates reliable. Fish monitoring efforts at RBDD and GCID on the upper Sacramento River have captured between 0 and 2,068 juvenile North American green sturgeon per year (Adams *et al.* 2002). The only existing information regarding changes in the abundance of the southern DPS of green sturgeon includes changes in abundance at the John E. Skinner Fish Facility between 1968 and 2001. The average number of North American green sturgeon taken per year at the State Facility prior to 1986 was 732; from 1986 on, the average per year was 47 (70 FR 17386). For the Harvey O. Banks Pumping Plant, the average number prior to 1986 was 889; from 1986 to 2001 the average was 32 (70 FR 17386). In light of the increased exports, particularly during the previous 10 years, it is clear that the abundance of the southern DPS of North American green sturgeon is dropping. Additional analysis of North American green and white sturgeon taken at the Fish Facilities indicates that take of both North American green and white sturgeon per acre-foot of water exported has decreased substantially since the 1960s (70 FR 17386). Catches of sub-adult and adult North American green sturgeon by the IEP between 1996 and 2004 ranged from 1 to 212 green sturgeon per year (212 occurred in 2001), however, the portion of the southern DPS of North American green sturgeon is unknown as these captures were primarily located in San Pablo Bay which is known to consist of a mixture of Northern and southern DPS North American green sturgeon. Recent spawning population estimates using sibling based genetics by Israel (2006) indicates a maximum spawning population of 32 spawners in 2002, 64 in 2003, 44 in 2004, 92 in 2005, and 124 in 2006 above RBDD (with an average of 71). Based on the length and estimated age of post-larvae captured at RBDD (approximately two weeks of age) and GCID (downstream; approximately three weeks of age), it appears the majority of southern DPS North American green sturgeon are spawning above RBDD. Note, there are many assumptions with this interpretation (*i.e.*, equal sampling efficiency and distribution of post-larvae across channels) and this information should be considered cautiously.

There are at least two records of confirmed adult sturgeon observation in the Feather River (Beamesderfer *et al.* 2004), however, there are no observations of juvenile or larval sturgeon even prior to the 1960s when Oroville Dam was built (NMFS 2005a). There are also unconfirmed reports that green sturgeon may spawn in the Feather River during high flow years (CDFG 2002).

Spawning in the San Joaquin River system has not been recorded, but alterations of the San Joaquin River tributaries (Stanislaus, Tuolumne, and Merced Rivers) and its mainstem occurred early in the European settlement of the region. During the later half of the 1800s impassable barriers were built on these tributaries where the water courses left the foothills and entered the valley floor. Therefore, these low elevation dams have blocked potentially suitable spawning habitats located further upstream for over a century. Additional destruction of riparian and stream channel habitat by industrialized gold dredging further disturbed any valley floor habitat that was still available for sturgeon spawning. It is likely that both white and green sturgeon utilized the San Joaquin River basin for spawning prior to the onset of European influence, based on past use of the region by populations of CV spring-run Chinook salmon and CV steelhead. These two populations of salmonids have either been extirpated or greatly diminished in their use of the San Joaquin River basin over the past two centuries.

The freshwater habitat of North American green sturgeon in the Sacramento-San Joaquin drainage varies in function, depending on location. Spawning areas currently are limited to accessible upstream reaches of the Sacramento River. Preferred spawning habitats are thought to contain large cobble in deep cool pools with turbulent water (CDFG 2002, Moyle 2002).

Migratory corridors are downstream of the spawning areas and include the mainstem Sacramento River and the Delta. These corridors allow the upstream passage of adults and the downstream emigration of outmigrant juveniles. Migratory habitat condition is strongly affected by the presence of barriers which can include dams, unscreened or poorly screened diversions, and degraded water quality. Both spawning areas and migratory corridors comprise rearing habitat for juveniles, which feed and grow before and during their 1 to 3 year residence in freshwater. Rearing habitat condition and function may be affected by variation in annual and seasonal flow and temperature characteristics.

Table 1. The temporal occurrence of adult (a) and juvenile (b) Sacramento River winter-run Chinook salmon in the Sacramento River. Darker shades indicate months of greatest relative abundance.

**a) Adult**

| Location | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sac. River basin[1] | Medium | Medium | High | Medium | Medium | Medium | Medium | | | | | Medium |
| Sac. River[2] | Medium | Medium | Medium | Medium | Medium | Medium | | | | | Medium | Medium |

**b) Juvenile**

| Location | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sac. River @ Red Bluff[3] | Low | | | | | | Low / Medium | Medium | Medium | Medium | Medium | Medium |
| Sac. River @ Red Bluff[2] | Medium | Medium | | | | | Low | High | High | High | Medium | Medium |
| Sac. River @ Knights L.[4] | Medium | Medium | Medium | Low | | | | Low | Low | Low | High | High |
| Lower Sac. River (seine)[5] | High | High | Medium | | | | | | | | Medium | High |
| West Sac. River (trawl)[5] | Medium | High | High | High | | | | | | | | Medium |

Source: [1]Yoshiyama *et al.* 1998; Moyle 2002; [2]Myers *et al.* 1998; [3]Martin *et al.* 2001; [4]Snider and Titus 2000; [5]USFWS 2001

Relative Abundance: = High = Medium = Low

Table 2. The temporal occurrence of adult (a) and juvenile (b) CV spring-run Chinook salmon in the Sacramento River. Darker shades indicate months of greatest relative abundance.

**(a) Adult**

| Location | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [1,2]Sac.River basin | | | | | | | | | | | | |
| [3]Sac. River | | | | | | | | | | | | |
| [4]Mill Creek | | | | | | | | | | | | |
| [4]Deer Creek | | | | | | | | | | | | |
| [4]Butte Creek | | | | | | | | | | | | |

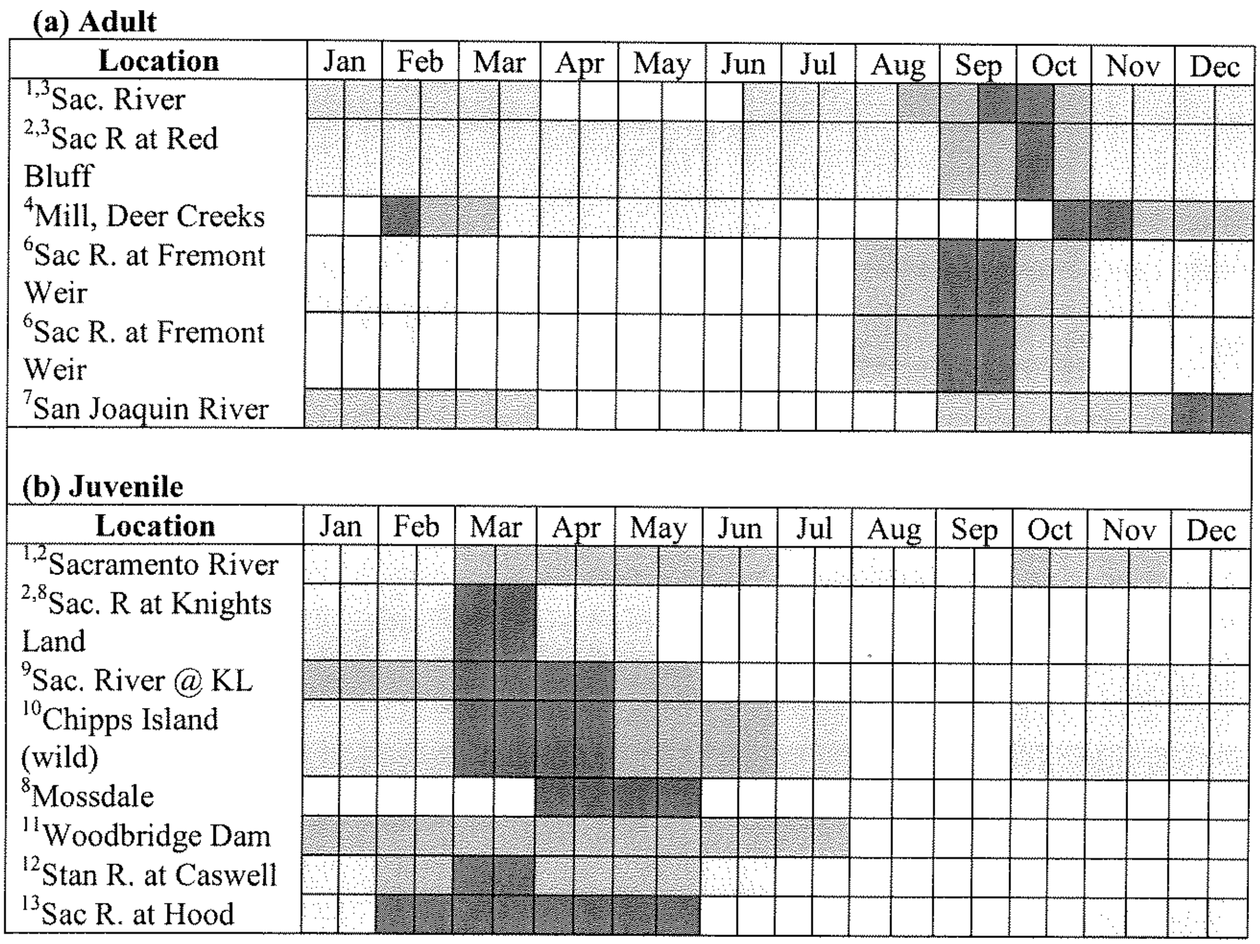
**(b) Juvenile**

| Location | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [5]Sac. River Tribs | | | | | | | | | | | | |
| [6]Upper Butte Creek | | | | | | | | | | | | |
| [4]Mill, Deer, Butte Creeks | | | | | | | | | | | | |
| [3]Sac. River at RBDD | | | | | | | | | | | | |
| [7]Sac. River at Knights Landing (KL) | | | | | | | | | | | | |

Source:[1]Yoshiyama *et al*. 1998; [2]Moyle 2002; [3]Myers *et al*. 1998; [4]Lindley *et al*. 2006a; [5]CDFG 1998; [6]McReynolds *et al*. 2005; Ward *et al*. 2002, 2003; [7]Snider and Titus 2000

Relative Abundance: = High = Medium = Low

Table 3. The temporal occurrence of adult (a) and juvenile (b) CV steelhead in the Central Valley. Darker shades indicate months of greatest relative abundance.




Source: [1]Hallock 1961; [2]McEwan 2001; [3]USFWS unpublished data; [4]CDFG 1995; [5]Hallock *et al*. 1957; [6]Bailey 1954; [7]CDFG Steelhead Report Card Data; [8]CDFG unpublished data; [9]Snider and Titus 2000; [10]Nobriga and Cadrett 2003; [11]Jones & Stokes Associates, Inc., 2002; [12]S.P. Cramer and Associates, Inc. 2000 and 2001; [13]Schaffter 1980

Table 4. The temporal occurrence of adult (a) larval and post-larval (b) juvenile (c) and coastal migrant (d) southern DPS of North American green sturgeon. Locations emphasize the Central Valley of California. Darker shades indicate months of greatest relative abundance.

**(a) Adult (≥13 years old for females and ≥9 years old for males)**

| Location | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [1,2,3]Upper Sac. River | Low | Low | Medium | Medium / High | High | High / Medium | Medium | Medium | Medium | Medium | Medium | Low |
| [4,8]SF Bay Estuary | Low | Low | Medium | Medium | Medium | Medium | Medium | Medium | Medium | Low | Low | Low |

**(b) Larval and post-larval (≤10 months old)**

| Location | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [5]RBDD, Sac River | Low | Low | Low | Low | Medium | High | High | Medium | Low | Low | Low | Low |
| [5]GCID, Sac River | Low | Low | Low | Low | Medium | High | High | Medium | Low | Low | Low | Low |

**(c) Juvenile (> 10 months old and ≤3 years old)**

| Location | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [6]South Delta* | Medium | Medium | Medium | Medium | Medium | Medium | Medium | Medium | Medium | Medium | Medium | Medium |
| [6]Sac-SJ Delta | Medium | Medium | Medium | Medium | Medium | Medium | Medium | Medium | Medium | Medium | Medium | Medium |
| [5]Sac-SJ Delta | Low | Low | Low | Medium | Medium | Medium | Medium | Medium | Medium | Medium | Low | Low |
| [5]Suisun Bay | Medium | Medium | Medium | Medium | Medium | Medium | Medium | Medium | Medium | Medium | Medium | Medium |

**(d) Coastal migrant (3-13 years old for females and 3-9 years old for males)**

| Location | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [3,7]Pacific Coast | Medium | Medium | Medium | Medium | Medium | Medium | Medium | Medium | Medium | Medium | Medium | Medium |

Source: [1]USFWS 2002; [2]Moyle *et al.* 1992; [3]Adams *et al.* 2002 and NMFS 2005a; [4]Kelley *et al.* 2006; [5]CDFG 2002; [6]Interagency Ecological Program Relational Database, fall midwater trawl green sturgeon captures from 1969 to 2003; [7]Nakamoto *et al.* 1995; [8]Heublein *et al.* 2006

* Fish Facility salvage operations

Relative Abundance: = High = Medium = Low

## B. Critical Habitat and Primary Constituent Elements

The designated critical habitat for Sacramento River winter-run Chinook salmon includes the Sacramento River from Keswick Dam (RM 302) to Chipps Island (RM 0) at the westward margin of the Delta; all waters from Chipps Island westward to Carquinez Bridge, including Honker Bay, Grizzly Bay, Suisun Bay, and Carquinez Strait; all waters of San Pablo Bay westward of the Carquinez Bridge; and all waters of San Francisco Estuary to the Golden Gate Bridge north of the San Francisco/Oakland Bay Bridge. In the Sacramento River, critical habitat includes the river water column, river bottom, and adjacent riparian zone used by fry and juveniles for rearing. In the areas westward of Chipps Island, critical habitat includes the estuarine water column and essential foraging habitat and food resources used by Sacramento River winter-run Chinook salmon as part of their juvenile emigration or adult spawning migration.

Critical habitat for CV spring-run Chinook salmon includes stream reaches such as those of the Feather and Yuba Rivers, Big Chico, Butte, Deer, Mill, Battle, Antelope, and Clear Creeks, and the Sacramento River and Delta. Critical Habitat for CV steelhead includes stream reaches such as those of the Sacramento, Feather, and Yuba Rivers, and Deer, Mill, Battle, and Antelope Creeks in the Sacramento River basin; and, the San Joaquin River its tributaries, and the Delta. Critical habitat includes the stream channels in the designated stream reaches and the lateral extent as defined by the ordinary high-water line. In areas where the ordinary high-water line has not been defined, the lateral extent will be defined by the bankfull elevation (70 FR 52488). The bankfull elevation is defined as the level at which water begins to leave the channel and move into the floodplain; it is reached at a discharge that generally has a recurrence interval of 1 to 2 years on the annual flood series (Dunne and Leopold 1978, MacDonald *et* al. 1991, Rosgen 1996). Critical habitat for CV spring-run Chinook salmon and steelhead is defined as specific areas that contain the primary constituent elements (PCE) and physical habitat elements essential to the conservation of the species. Following are the inland habitat types used as PCEs for CV spring-run Chinook salmon and CV steelhead, and as physical habitat elements for Sacramento River winter-run Chinook salmon.

1. Spawning Habitat

Freshwater spawning sites are those with water quantity and quality conditions and substrate supporting spawning, incubation, and larval development. Most spawning habitat in the Central Valley for Chinook salmon and steelhead is located in areas directly downstream of dams containing suitable environmental conditions for spawning and incubation. Spawning habitat for Sacramento River winter-run Chinook salmon is restricted to the Sacramento River primarily between RBDD and Keswick Dam. CV spring-run Chinook salmon also spawn on the mainstem Sacramento River between RBDD and Keswick Dam and in tributaries such as Mill, Deer, and Butte Creeks. Spawning habitat for CV steelhead is similar in nature to the requirements of Chinook salmon, primarily occurring in reaches directly below dams (*i.e.*, above RBDD on the Sacramento River) throughout the Central Valley. Most remaining natural spawning habitats (those not downstream from large dams) currently are in good condition, with adequate water temperatures, stream flows, and gravel conditions to support successful reproduction. Some areas below dams, especially for steelhead are degraded by fluctuating flow conditions related to water storage and flood management, that scour or strand redds. Spawning habitat has a high conservation value as its function directly affects the spawning success and reproductive potential of listed salmonids.

2. Freshwater Rearing Habitat

Freshwater rearing sites are those with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood, log jams, beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks. Both spawning areas and migratory corridors comprise rearing habitat for juveniles, which feed and grow before and during their outmigration. Non-natal, intermittent tributaries also may be used for juvenile rearing. Rearing habitat condition is strongly affected by habitat complexity, food supply, and presence of predators of juvenile salmonids. Some complex, productive habitats with floodplains remain in the system (*e.g.*, the lower Cosumnes River, Sacramento River reaches with set-back levees [*i.e.*, primarily located upstream of the City of Colusa]). However, the channeled, leveed, and riprapped river reaches and sloughs that are common in the Sacramento-San Joaquin system typically have low habitat complexity, low abundance of food organisms, and offer little protection from either fish or avian predators. Freshwater rearing habitat also has a high conservation value as the juvenile life stage of salmonids is dependant on the function of this habitat for successful survival and recruitment. Thus, although much of the rearing habitat is in poor condition, it is important to the species.

3. Freshwater Migration Corridors

Ideal freshwater migration corridors are free of obstruction with adequate water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility, survival and food supply. Migratory corridors are downstream of the spawning area and include the lower Sacramento River and the Delta. These corridors allow the upstream passage of adults, and the downstream emigration of outmigrant juveniles. Migratory habitat condition is strongly affected by the presence of barriers, which can include dams, unscreened or poorly- screened diversions, and degraded water quality. For successful survival and recruitment of salmonids, freshwater migration corridors must function sufficiently to provide adequate passage. For adults, upstream passage through the Delta and the much of the Sacramento River is not a problem, but problems exist on many tributary streams, and at the RBDD. For juveniles, unscreened or inadequately screen water diversions throughout their migration corridors, and a scarcity of complex in-river cover have degraded this PCE. However, since the primary migration corridors are used by numerous populations, and are essential for connecting early rearing habitat with the ocean even the degraded reaches are considered to have a high conservation value to the species. Thus, although much of the migration corridor is in poor condition, it is important to the species.

4. Estuarine Areas

Estuarine areas free of obstruction with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh and salt water are included as a PCE. Natural cover such as submerged and overhanging large wood, aquatic vegetation, and side channels, are suitable for juvenile and adult foraging. The remaining estuarine habitat for these species is severely degraded by altered hydrologic regimes, poor water quality, reductions in habitat complexity, and competition for food and space with exotic species. Regardless of the condition, the remaining estuarine areas are of high conservation value because they function as predator avoidance and as a transition to the ocean environment.

## C. Factors Affecting the Species and Critical Habitat

### 1. Sacramento River Winter-run Chinook Salmon, Central Valley Steelhead, and Spring-run Chinook Salmon

A number of documents reviewed by NMFS for this biological opinion address the history of human activities, present environmental conditions, and factors contributing to the decline of salmon and steelhead species in the Central Valley. For example, NMFS prepared range-wide status reviews for west coast Chinook salmon (Myers *et al.* 1998) and steelhead (Busby *et al.* 1996). Also, the NMFS Biological Review Team (BRT) published a draft updated status review for west coast Chinook salmon and steelhead in November 2003 (NMFS 2003a), and an additional updated and final draft in 2005 (Good *et al.* 2005). NMFS also assessed the factors for Chinook salmon and steelhead decline in supplemental documents (NMFS 1996, 1998). Information also is available in Federal Register notices announcing ESA listing proposals and determinations for some of these species and their critical habitat (*e.g.*, 58 FR 33212; 59 FR 440; 62 FR 24588; 62 FR 43937; 63 FR 13347; 64 FR 24049; 64 FR 50394; 65 FR 7764). The Final Programmatic Environmental Impact Statement/Report (EIS/EIR) for the CALFED Program (CALFED 2000), and the Final Programmatic EIS for the CVPIA provide a summary of historical and recent environmental conditions for salmon and steelhead in the Central Valley. The following general description of the factors affecting Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CV steelhead, and their critical habitat is based on a summarization of these documents.

In general, the human activities that have affected listed anadromous salmonids and the PCEs of their critical habitats consist of: (1) the present or threatened destruction, modification, or curtailment of habitat or range; (2) over-utilization; (3) disease or predation; (4) the inadequacy of existing regulatory mechanisms; and (5) other natural and manmade factors, including habitat and ecosystem restoration, and global climate change. All of these factors have contributed to the ESA-listing of these fish and deterioration of their critical habitat. However, it is widely recognized in numerous species accounts in the peer-reviewed literature that the modification and curtailment of habitat and range have had the most substantial impacts on the abundance, distribution, population growth, and diversity of salmonid ESUs. Although habitat and ecoystem restoration has contributed to population stability and increases in abundance throughout the ESUs, global climate change remains a looming threat.

*a. Modification and Curtailment of Habitat and Range*

Modification and curtailment of habitat and range from hydropower, flood control, and consumptive water use have permanently blocked or hindered salmonid access to historical spawning and rearing grounds resulting in the complete loss of substantial portions of spawning, rearing, and migration PCEs. Clark (1929) estimated that originally there were 6,000 linear miles of salmon habitat in the Central Valley system and that 80 percent of this habitat had been lost by 1928. Yoshiyama *et al.* (1996) calculated that roughly 2,000 linear miles of salmon habitat actually was available before dam construction and mining, and concluded that 82 percent is not accessible today. Yoshiyama *et al.* (1996) surmised that steelhead habitat loss was even greater than salmon loss, as steelhead migrated farther into drainages. In general, large dams on every major tributary to the Sacramento River, San Joaquin River, and the Delta block salmon and steelhead access to the upper portions of their respective watersheds. The loss of upstream habitat has required Chinook salmon and steelhead to use less hospitable reaches below dams. The loss of substabtial habitat above dams also has resulted in decreased juvenile and adult steelhead survival during migration, and in many cases, has resulted in the dewatering and loss of important spawning and rearing habitats.

The diversion and storage of natural flows by dams and diversion structures on CV waterways have depleted stream flows and altered the natural cycles by which juvenile and adult salmonids have evolved. Changes in stream flows and diversions of water affect spawning habitat, freshwater rearing habitat, freshwater migration corridors, and estuarine habitat PCEs. As much as 60 percent of the natural historical inflow to Central Valley watersheds and the Delta have been diverted for human uses. Depleted flows have contributed to higher temperatures, lower dissolved oxygen (DO) levels, and decreased recruitment of gravel and IWM. More uniform flows year-round have resulted in diminished natural channel formation, altered food web processes, and slower regeneration of riparian vegetation. These stable flow patterns have reduced bedload movement, caused spawning gravels to become embedded, and decreased channel widths due to channel incision, all of which has decreased the available spawning and rearing habitat below dams.

Water withdrawals, for agricultural and municipal purposes have reduced river flows and increased temperatures during the critical summer months, and in some cases, have been of a sufficient magnitude to result in reverse flows in the lower San Joaquin River (Reynolds *et al.* 1993). Direct relationships exist between water temperature, water flow, and juvenile salmonid survival (Brandes and McLain 2001). High water temperatures in the Sacramento River have limited the survival of young salmon.

The development of the water conveyance system in the Delta has resulted in the construction of more than 1,100 miles of channels and diversions to increase channel elevations and flow capacity of the channels (Mount 1995). Levee development in the Central Valley affects spawning habitat, freshwater rearing habitat, freshwater migration corridors, and estuarine habitat PCEs. The construction of levees disrupts the natural processes of the river, resulting in a multitude of habitat-related effects that have diminished conditions for adult and juvenile migration and survival.

Many of these levees use angular rock (riprap) to armor the bank from erosive forces. The effects of channelization, and riprapping, include the alteration of river hydraulics and cover along the bank as a result of changes in bank configuration and structural features (Stillwater Sciences 2006). These changes affect the quantity and quality of nearshore habitat for juvenile salmonids and have been thoroughly studied (USFWS 2000, Schmetterling *et al.* 2001, Garland *et al.* 2002). Simple slopes protected with rock revetment generally create nearshore hydraulic conditions characterized by greater depths and faster, more homogeneous water velocities than occur along natural banks. Higher water velocities typically inhibit deposition and retention of sediment and woody debris. These changes generally reduce the range of habitat conditions typically found along natural shorelines, especially by eliminating the shallow, slow-velocity river margins used by juvenile fish as refuge and escape from fast currents, deep water, and predators (Stillwater Sciences 2006).

Large quantities of downed trees are a functionally important component of many streams (NMFS 1996). Large woody debris influences channel morphology by affecting longitudinal profile, pool formation, channel pattern and position, and channel geometry. Downstream transport rates of sediment and organic matter are controlled in part by capture of this material within and behind large wood. Large wood affects the formation and distribution of habitat units, provides cover and complexity, and acts as a substrate for biological activity (NMFS 1996). Wood enters streams inhabited by salmonids either directly from adjacent riparian zones or from riparian zones in adjacent non-fish bearing tributaries. Removal of riparian vegetation and instream woody material (IWM) from the streambank results in the loss of a primary source of overhead and instream cover for juvenile salmonids. The removal of riparian vegetation and IWM and the replacement of natural bank substrates with rock revetment can adversely affect important ecosystem functions. Living space and food for terrestrial and aquatic invertebrates is lost, eliminating an important food source for juvenile salmonids. Loss of riparian vegetation and soft substrates reduces inputs of organic material to the stream ecosystem in the form of leaves, detritus, and woody debris, which can affect biological production at all trophic levels. The magnitude of these effects depends on the degree to which riparian vegetation and natural substrates are preserved or recovered during the life of the project.

In addition, the armoring and revetment of stream banks tends to narrow rivers, reducing the amount of habitat per unit channel length (Sweeney *et al.* 2004). As a result of river narrowing, benthic habitat decreases and the number of macroinvertebrates, such as stoneflies and mayflies, per unit channel length decreases affecting salmonid food supply.

b. *Ecosystem Restoration*

The CVPIA, implemented in 1992, requires that fish and wildlife get equal consideration with other demands for water allocations derived from the CVP. From this act arose several programs that have benefited listed salmonids: the Anadromous Fish Restoration Program (AFRP), the Anadromous Fish Screen Program (AFSP), and the Water Acquisition Program (WAP). The AFRP is engaged in monitoring, education, and restoration projects geared toward doubling the natural populations of select anadromous fish species residing in the Central Valley. Restoration projects funded through the AFRP include fish passage, fish screening, riparian easement and land acquisition, development of watershed planning groups, instream and riparian habitat improvement, and gravel replenishment. The AFSP combines Federal funding with State and private funds to prioritize and construct fish screens on major water diversions mainly in the upper Sacramento River. The goal of the WAP is to acquire water supplies to meet the habitat restoration and enhancement goals of the CVPIA and to improve the Department of Interior's ability to meet regulatory water quality requirements. Water acquisition has been used successfully to improve fish habitat for CV spring-run Chinook salmon and CV steelhead by maintaining or increasing instream flows in Butte and Mill Creeks and the San Joaquin River at critical times.

Two programs included under CALFED; the Ecosystem Restoration Program (ERP) and the EWA, were created to improve conditions for fish, including listed salmonids, in the Central Valley. Restoration actions implemented by the ERP include the installation of fish screens, modification of barriers to improve fish passage, habitat acquisition, and instream habitat restoration. The majority of these actions address key factors affecting listed salmonids and emphasis has been placed in tributary drainages with high potential for CV steelhead and CV spring-run Chinook salmon production. Additional ongoing actions include new efforts to enhance fisheries monitoring and directly support salmonid production through hatchery releases. Recent habitat restoration initiatives sponsored and funded primarily by the CALFED-ERP have resulted in plans to restore ecological function to 9,543 acres of shallow-water tidal and marsh habitats within the Delta. Restoration of these areas primarily involves flooding lands previously used for agriculture, thereby creating additional rearing habitat for juvenile salmonids.

The CDWR's Four Pumps Agreement Program has approved approximately $49 million for projects that benefit salmon and steelhead production in the Sacramento-San Joaquin basins and Delta since the agreements inception in 1986. Four Pumps projects that benefit CV spring-run Chinook salmon and steelhead include water exchange programs on Mill and Deer Creeks; enhanced law enforcement efforts from San Francisco Estuary upstream to the Sacramento and San Joaquin Rivers and their tributaries; design and construction of fish screens and ladders on Butte Creek; and, screening of diversions in Suisun Marsh and San Joaquin tributaries. Predator habitat isolation and removal, and spawning habitat enhancement projects on the San Joaquin tributaries benefit steelhead.

c. *Climate Change*

The world is about 1.3 °F warmer today than a century ago and the latest computer models predict that, without drastic cutbacks in emissions of carbon dioxide and other gases released by the burning of fossil fuels, the average global surface temperature may rise by two or more degrees in the 21st century (Intergovernmental Panel on Climate Change [IPCC] 2001). Much of that increase will likely occur in the oceans, and evidence suggests that the most dramatic changes in ocean temperature are now occurring in the Pacific (Noakes 1998). Using objectively analyzed data Huang and Liu (2000) estimated a warming of about 0.9 °F per century in the Northern Pacific Ocean.

An alarming prediction is the fact that Sierra snow packs are expected to decrease with global warming and that the majority of runoff in California will be from rainfall in the winter rather than from melting snow pack in the mountains (CDWR 2006). This will alter river runoff patterns and transform the tributaries that feed the Central Valley from a spring/summer snowmelt dominated system to a winter rain dominated system. It can be hypothesized that summer temperatures and flow levels will become unsuitable for salmonid survival. The cold snowmelt that furnishes the late spring and early summer runoff will be replaced by warmer precipitation runoff. This should truncate the period of time that suitable cold-water conditions exist below existing reservoirs and dams due to the warmer inflow temperatures to the reservoir from rain runoff. Without the necessary cold-water pool developed from melting snow pack filling reservoirs in the spring and early summer, late summer and fall temperatures below reservoirs, such as Lake Shasta, potentially could rise above thermal tolerances for juvenile and adult salmonids (*i.e.* Sacramento River winter-run Chinook salmon and CV steelhead) that must hold below the dam over the summer and fall periods.

2. <u>Critical Habitat for Salmonids</u>

According the NMFS CHART report (2005b) the major categories of habitat-related activities affecting Central Valley salmonids include: (1) irrigation impoundments and withdrawals (2) channel modifications and levee maintenance, (4) the presence and operation of hydroelectric dams, (5) flood control and streambank stabilization, and (6) exotic and invasive species introductions and management. All of these activities affect PCEs via their alteration of one or more of the following: stream hydrology, flow and water-level modification, fish passage, geomorphology and sediment transport, temperature, DO levels, nearshore and aquatic vegetation, soils and nutrients, physical habitat structure and complexity, forage, and predation (Spence *et al.* 1996). According to the NMFS CHART report (2005b), the condition of critical habitat varies throughout the range of the species. The condition value of existing spawning habitat ranges from moderate to high quality, with the primary threats including changes to water quality, and spawning gravel composition from rural, suburban, and urban development, forestry, and road construction and maintenance. Downstream, river and estuarine migration and rearing corridors range in condition from poor to high quality depending on location. Tributary migratory and rearing corridors tended to rate as moderate quality due to threats to adult and juvenile life stages from irrigation diversion, small dams, and water quality. Delta (*i.e.*, estuarine) and mainstem Sacramento and San Joaquin river reaches tended to range from poor to moderately-high quality, depending on location. In the alluvial reach of the Sacramento River between Red Bluff and Colusa, the PCEs of rearing and migration habitat are in better conditions than the lower river because, despite the influence of upstream dams, this reach retains natural, and functional channel processes that maintain and develop anadromous fish habitat. The river reach downstream from Colusa and including the Delta is poor in quality due to impaired hydrologic conditions from dam operations, water quality from agriculture, degraded nearshore and riparian habitat from levee construction and maintenance, and habitat loss and fragmentation.

Although there are degraded habitat conditions within the action area, NMFS considers the value of this area for the conservation of the species to be high because its entire length is used for migration and rearing during extended periods of time by a large proportion of all Federally listed anadromous fish species in the Central Valley. NMFS considers an area to be of high conservation value, regardless of its current condition, where conservation of the area's habitat PCEs is highly valuable to the ESUs that depend on that area.

3. <u>Southern Distinct Population Segment of North American Green Sturgeon</u>

The principal factors for the decline in the southern DPS of North American green sturgeon are reviewed in the proposed listing notice (70 FR 17386) and status reviews (Adams *et al.* 2002, NMFS 2005b), and primarily consist of: (1) the present or threatened destruction, modification, or curtailment of habitat or range; (2) poor water quality; (3) over-utilization; (4) increased water temperatures; (5) non-native species, and (6), other natural and manmade factors, including habitat and ecosystem restoration, and global climate change.

NMFS (2005) concluded that the principle threat to green sturgeon is impassible barriers, primarily Keswick and Shasta Dams on the Sacramento River and Oroville Dam on the Feather River that likely block and prevent access to historic spawning habitat (NMFS 2005a). Spawning habitat may have extended up into the three major branches of the Sacramento River; the Little Sacramento River, the Pit River system, and the McCloud River (NMFS 2005a). In contrast, recent modeling evaluations by Mora (2006) indicate little or no habitat in the little Sacramento River or the Pit River exists above Shasta dam; however, a considerable amount of habitat exists above Shasta on the mainstem Sacramento River. Green and white sturgeon adults have been observed periodically in the Feather and Yuba River (USFWS 1995, Beamesderfer *et al.* 2004, Jeff McLain, NMFS, pers. comm., 2006) and habitat modeling my Mora (2006) suggests there is sufficient habitat above Oroville Dam. There are no records of larval or juvenile white or green sturgeon being captured on the Feather River; however, there are reports that green sturgeon may reproduce in the Feather River during high flow years (CDFG 2002), but these are unconfirmed.

No green sturgeon have been documented in the San Joaquin River; however, the presence of white sturgeon has been documented (USFWS 1995, Beamesderfer *et al.* 2004) making the historical presence of green sturgeon likely as the two species require similar habitat and their ranges overlap in the Sacramento River. Habitat modeling by Mora (2006) also suggests sufficient conditions are present in the San Joaquin River to Friant Dam, and in the Stanislaus, Tuolumne, and Merced Rivers to the dams. In addition, the San Joaquin River had the largest spring-run Chinook salmon population in the Central Valley prior to the construction of Friant Dam (Yoshiyama *et al.* 2001) with escapements approaching 500,000 fish. Thus it is very possible, based on prior spring-run Chinook salmon distribution and habitat use of the San Joaquin River, that green sturgeon were extirpated from the San Joaquin basin in a similar manner to spring-run Chinook salmon. The loss of potential green sturgeon spawning habitat on the San Joaquin River also may have contributed to the overall decline of the southern DPS of North American green sturgeon.

The potential effects of climate change were discussed in the Chinook Salmon and Central Valley Steelhead sections and primarily consist of altered ocean temperatures and stream flow patterns in the Central Valley. Changes in Pacific Ocean temperatures can alter predator prey relationships and affect migratory habitat of the southern DPS of North American green sturgeon. Increases in rainfall and decreases in snow pack in the Sierra Nevada range will affect cold-water pool storage in reservoirs affecting river temperatures. As a result, the quantity and quality of water that may be available to maintain habitat for the southern DPS of North American green sturgeon will likely significantly decrease.

## IV. ENVIRONMENTAL BASELINE

The environmental baseline "includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process" (50 CFR §402.02). The action area considered in this biological opinion is the vicinity (*i.e.*, within 2000 feet) of RM 192.5R on the Sacramento River (Figure 10).

### A. Status of the Species and Critical Habitat in the Action Area

1. Status of the Species within the Action Area

The status of the species in the action area is similar to the entire population status in the Sacramento River Basin. The action area is in the mainstem of the Sacramento River and functions as a migratory corridor for adult Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CV steelhead, and provides migration and rearing habitat for juveniles of these species. The action area also functions as a migratory and holding corridor for adult and rearing and migratory habitat for juvenile southern DPS of North American green sturgeon. A large proportion of all Federally listed Central Valley salmonids and sturgeon are expected to utilize aquatic habitat within the action area, primarily because the action area is located downstream from primary spawning populations.

a. *Sacramento River Winter-run Chinook Salmon*

Adult Sacramento River winter-run Chinook salmon are expected to be present in the Sacramento River portion of the action area between November and June (Myers *et al.* 1998, Good *et al.*

2005) as they migrate to spawning grounds. Juvenile Sacramento River winter-run Chinook salmon migration patterns in the Sacramento River can be determined by evaluating juvenile salmonid outmigration timing at the GCID rotary screw trap, located less than 15 miles upstream of the action area, and the Knights Landing rotary screw trap, located approximately 90 miles downstream. Rotary screw traps summaries at GCID, by DFG on the Sacramento River show juvenile captures between July and April, with heaviest densities observed first during September and October. Rotary screw traps summaries at Knights Landing on the Sacramento River by Snider and Titus (2000) show juvenile captures between August and April, with heaviest densities observed first during November and December, and second during January through March. Based on these comparisons, winter-run Chinook salmon are expected to be within the action area between September and March, with the peak of the migration occurring from mid October to early November.

b. *Central Valley Spring-run Chinook Salmon*

Adult CV spring-run Chinook salmon are expected to migrate through the action area between March and July (Myers *et al.* 1998, Good *et al.* 2005). Peak presence is believed to be during February and March (CDFG 1998). In the Sacramento River and other major tributaries (i.e., Feather River, Deer, Butte, and Mill Creeks), juveniles may begin migrating downstream almost immediately following emergence from the gravel with most emigration occurring from December through March (Moyle *et. al.* 1989, Vogel and Marine 1991). Snider and Titus (2000) observed that up to 69 percent of spring-run Chinook salmon emigrate during the first migration phase between November and early January. The remainder of the CV spring-run Chinook salmon emigrate during subsequent phases that extend into early June of the following year. The age structure of emigrating juveniles is comprised of YOY and yearlings. The exact composition of the age structure is not known, although populations from Mill and Deer Creek primarily emigrate as yearlings (Colleen Harvey-Arrison, CDFG, pers. comm., 2004), and fish from Butte Creek primarily emigrate as fry (Ward *et. al.* 2002).

c. *Central Valley Steelhead*

The proportion of steelhead in this DPS that migrate through the action area is unknown. However, because of the relatively large amount of suitable habitat in the Sacramento River and its tributaries (*i.e.*, Battle, Antelope, Mill, Deer, Clear Creeks) relative to the San Joaquin River Basin, it is probably high. Adult steelhead may be present in all parts of the action area from June through March, with the peak occurring between August and October (Bailey 1954, Hallock *et al.* 1957). The highest abundance of adults and juveniles is expected in the Sacramento River part of the action area. Juvenile steelhead emigrate through the Sacramento River from late fall to spring. Snider and Titus (2000) observed that juvenile steelhead emigration primarily occurs between November and May at Knights Landing. The majority of juvenile steelhead emigrate as yearlings and are assumed to be primarily utilizing the center of the channel rather than the shoreline.

d. *Southern DPS of North American Green Sturgeon*

The spawning population of the southern DPS of North American green sturgeon is currently restricted to the Sacramento River below Keswick Dam, and is composed of a single breeding population (*Status of the Species and Critical Habitat* section). There are recent reports that North American green sturgeon may reproduce in the Feather River, and they have been observed in the Yuba River during high flow years (CDFG 2002b), but these are not specific and are unconfirmed (S.P. Cramer & Associates, Inc. 2004). In the Yuba River, over the last decade, only two adult sturgeon (unconfirmed species but believed to be white sturgeon) have been documented in the lower Yuba River (Bill Mitchell, Jones and Stokes, pers. comm., 2004). Both were observed holding in the large hole below Daguerre Point Dam (RM 12) during the 1990s. Additional unconfirmed sightings of adult sturgeon (species unknown) have been periodically reported to CDFG in recent years (Ian Drury, CDFG, pers. comm., 2005). Therefore, it appears that a large, although unknown, portion of the population of adults and juveniles must pass through the action area.

The action area is utilized by the southern DPS of North American green sturgeon adults for migration purposes. Adult green sturgeon migrate upstream through the action area primarily between March and June (Adams *et al.* 2002). Larva and post-larvae are present on the lower Sacramento River between May and October, primarily during June and July (CDFG 2002). Small numbers of juvenile green sturgeon have been captured at various locations on the Sacramento River as well as in the Delta during all months of the year (IEP Database, Borthwick *et al.* 1999).

2. Status of Critical Habitat Within the Action Area

The action area is within designated critical habitat for Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CV steelhead. Habitat requirements for these species are similar. The PCEs of salmonid habitat within the action area include: freshwater rearing habitat and freshwater migration corridors containing adequate substrate, water quality, water quantity, water temperature, water velocity, cover/shelter, food; riparian vegetation, space, and safe passage conditions. Habitat within the action area is primarily used for juvenile and smolt freshwater rearing and migration and for adult freshwater migration. The condition and function of this habitat has been severely impaired through several factors discussed in the *Status of the Species and Habitat* section of this biological opinion. The result has been the reduction in quantity and quality of several essential elements of migration and rearing habitat required by juveniles to grow, and survive. In spite of the degraded condition of this habitat, the conservation value of the action area is high because its entire length is used for extended periods of time by a large proportion of all Federally listed anadromous fish species in the Central Valley.

Presently, the M&T Chico Ranch/Llano Seco Rancho pumping facility provides a reliable water supply to about 15,000 acres of farmland, refuge land, and wildlife management areas including over 4,000 acres of wetlands owned or managed by the USFWS and CDFG providing key wetland habitat for waterfowl and other wetland species. The M&T Chico Ranch/Llano Seco Rancho pumping facility is located immediately downstream of the confluence of Big Chico Creek and the Sacramento River, on the east bank of the Sacramento River just south of the Bidwell-Sacramento River State Park at RM 193. The diversion in Central Valley waterways have depleted streamflows and altered the natural cycles by which juvenile and adult salmonids have evolved. Changes in streamflows and diversions of water affect freshwater rearing habitat and freshwater migration corridor PCEs in the action area. Approximately 300 feet downstream from the M&T Chico Ranch/Llano Seco Rancho pumping facility is the City of Chico Waste Water Treatment Plant (WWTP) outfall, which discharges into the Sacramento River. The City of Chico WWTP supports various land-use activities in the action area such as urbanization and agricultural encroachment have resulted in habitat simplification. Runoff from residential and industrial areas also contributes to water quality degradation (Regional Board 1998). Urban stormwater runoff contains pesticides, oil, grease, heavy metals, polynuclear aromatic hydrocarbons, other organics and nutrients (Regional Board 1998) that contaminate drainage waters and destroy aquatic life necessary for salmonid survival (NMFS 1996). In addition, juvenile salmonids are exposed to increased water temperatures as a result of thermal inputs from municipal, industrial, and agricultural discharges in the action area.

## B. Factors Affecting the Species and Habitat in the Action Area

1. <u>Sacramento River Winter-run Chinook Salmon, Central Valley Steelhead, and Spring-run Chinook Salmon</u>

The magnitude and duration of peak flows during the winter and spring are reduced by water impoundment in upstream reservoirs affecting listed salmonids in the action area. Instream flows during the summer and early fall months have increased over historic levels for deliveries of municipal and agricultural water supplies. Overall, water management now reduces natural variability by creating more uniform flows year-round. Current flood control practices require peak flood discharges to be held back and released over a period of weeks. Consequently, the mainstream of the river often remains too high and turbid to provide quality rearing habitat.

2. <u>Southern Distinct Population Segment of North American Green Sturgeon</u>

Point source and non-point source pollution resulting from agricultural discharge and urban and industrial development occurs in the action area. The effects of these impacts are discussed in detail in the *Status of the Species and Habitat* section. Environmental stresses resulting from poor water quality can lower reproductive success and may account for low productivity rates of green sturgeon (Klimley 2002). Organic contaminants from agricultural drain water, urban and agricultural runoff from storm events, and high trace element concentrations may deleteriously affect early life-stage survival of fish in the Sacramento River (USFWS 1995). Principle sources of organic contamination in the Sacramento River are rice field discharges, downstream from the action area.

The Sacramento River is utilized by larvae and post-larvae and to a lesser extent, juvenile North American green sturgeon for rearing and migration purposes. Although it is believed that larvae and post-larvae as well as juveniles primarily are benthic (with the exception of the post-larvae nocturnal swim-up believed to be a dispersal mechanism), the massive channelization effort in the action area has resulted in a loss of ecosystem function (USFWS 2000, Sweeney *et al.* 2004). Channelization results in reduced food supply (aquatic invertebrates), and reduced pollutant processing, organic matter processing, and nitrogen uptake (Sweeney *et al.* 2004).

The M&T Chico Ranch/Llano Seco Rancho pumping facility is the only diversion in the action area on the Sacramento River and is a potential threat to the southern DPS of North American green sturgeon. NMFS assumes larval green sturgeon may be susceptable to entrainment primarily from benthic water diversion facilities during the first 5 days of development and suseptable to diversion entrainment from facilities drawing water from the bottom and top of the water column when they are exhibiting noctornal behavior (starting at day 6). Reduced flows in the action area likely affect year class strength of the southern DPS of North American green sturgeon as increased flows have been found to improve year class strength.

**C. Likelihood of Species Survival and Recovery and Conservation Value of Critical Habitat in the Action Area**

In their recent evaluation of the viability of Central Valley salmonids, Lindley et al. (2007) found that extant populations of Sacramento River winter-run Chinook salmon and CV spring-run Chinook salmon appear to be fairly viable. These populations meet several viability criteria including population size, growth, and risk from hatchery strays. The viability of the ESU to which these populations belong appears low to moderate, yet the ESU remains vulnerable to extirpation due to their small-scale distribution and high likelihood of being affected by a significant catastrophic event. Lindley et al. (2007) were not able to determine the viability of existing steelhead populations, but believe that the DPS has a moderate to high risk of extirpation since most of the historic habitat is inaccessible due to dams, and because the anadromous life-history strategy is being replaced by residency.

The southern DPS of North American green sturgeon utilize the mainstem Sacramento River for spawning, rearing, and migration purposes. In addition, the southern DPS of North American green sturgeon are known to occur in Delta areas, and recently have been seen in the Feather and Yuba River. Habitats of the Sacramento River are very important for the southern DPS of North American green sturgeon as they are the only know location for spawning. Recent population estimates indicate that there are few fish relative to historic conditions, and that loss of habitat has affected population size and distribution. However, the southern DPS of North American green sturgeon remain widely distributed along the Pacific coast from California to Washington, and recent findings of fish in the Feather and the Yuba River indicate that their distribution in the Central Valley may be more broad than previously thought. This suggests that the DPS probably meets several viable species population criteria for distribution and diversity, and indicates that the southern DPS of North American green sturgeon faces a low to moderate risk of extirpation.

Based on these viability assessments, and the recent habitat improvements that are occurring throughout the Sacramento River Basin to improve the conservation value of aquatic habitat for listed fish, Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead have a moderate to high likelihood of extinction in the actin area

## V. EFFECTS OF THE ACTION

### A. Approach to the Assessment

Pursuant to section 7(a)(2) of the Endangered Species Act (ESA) (16 U.S.C. §1536), Federal agencies are directed to ensure that their activities are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat. This biological opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.02. Instead, we have relied upon the statutory provisions of the ESA to complete the following analysis with respect to critical habitat. NMFS will evaluate destruction or adverse modification of critical habitat by determining if the action reduces the value of critical habitat for the conservation of the species. This biological opinion assesses the effects of the proposed action on endangered Sacramento River winter-run Chinook salmon, threatened Central Valley spring-run Chinook salmon, threatened Central Valley steelhead, their designated critical habitat, and threatened southern DPS of North American green sturgeon.

In the *Description of the proposed action* section of this biological opinion, NMFS provided an overview of the action. In the *Status of the Species* and *Environmental Baseline* sections of this biological opinion, NMFS provided an overview of the threatened and endangered species and critical habitat that are likely to be adversely affected by the activity under consultation.

Regulations that implement section 7(b)(2) of the ESA require biological opinions to evaluate the direct and indirect effects of Federal actions and actions that are interrelated with or interdependent to the Federal action to determine if it would be reasonable to expect them to appreciably reduce listed species' likelihood of surviving and recovering in the wild by reducing their reproduction, numbers, or distribution (16 U.S.C. §1536; 50 CFR 402.02). Section 7 of the ESA and its implementing regulations also require biological opinions to determine if Federal actions would destroy or adversely modify the conservation value of critical habitat (16 U.S.C. §1536).

NMFS generally approaches "jeopardy" analyses in a series of steps. First, we evaluate the available evidence to identify the direct and indirect physical, chemical, and biotic effects of proposed actions on individual members of listed species or aspects of the species' environment (these effects include direct, physical harm or injury to individual members of a species;

modifications to something in the species' environment - such as reducing a species' prey base, enhancing populations of predators, altering its spawning substrate, altering its ambient temperature regimes; or adding something novel to a species' environment - such as introducing exotic competitors or a sound. Once we have identified the effects of an action, we evaluate the available evidence to identify a species' probable response (including behavioral responses) to those effects to determine if those effects could reasonably be expected to reduce a species' reproduction, numbers, or distribution (for example, by changing birth, death, immigration, or emigration rates; increasing the age at which individuals reach sexual maturity; decreasing the age at which individuals stop reproducing; among others). We then use the evidence available to determine if these reductions, if any, could reasonably be expected to appreciably reduce a species' likelihood of surviving and recovering in the wild.

To evaluate the effects of the proposed action, NMFS examined proposed construction activities, O&M activities, habitat modification, and conservation measures, to identify likely impacts to listed anadromous salmonids within the action area based on the best available information.

The information used in this assessment includes fishery information previously described in the *Status of the Species* and *Environmental Baseline* sections of this biological opinion; studies and accounts of the impacts of riprapping and in-river construction activities on anadromous habitat and ecosystem function; and documents prepared in support of the proposed action, including the project description contained in the *M&T Chico Ranch/Llano Seco Rancho Pumping Plant Maintenance of Channel Alignment River Mile 192.5: Action Specific Implementation Plan,* on site visits, and meetings held between the Corps, NMFS, USFWS, and CDFG, representatives of the ranch and of other interested parties such as DU.

**B. Assessment**

The assessment of effects considers the potential occurrence of Federally listed Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CV steelhead, and the southern DPS of North American green sturgeon, relative to the magnitude, timing, and duration of project activities. Effects of the proposed project on aquatic resources include both construction activities and the 5-year period impacts. Short-term effects, which are related primarily to construction activities (*i.e.*, increased suspended sediment and turbidity), may last several hours to several weeks. Long-term impacts may last months up to 5-years and generally involve physical alteration of the river bank and riparian vegetation adjacent to the water's edge.

1. <u>Effects of the bank revetment and brush revetment at RM 192R.</u>

Construction activities include rock and brush revetment and removal after 5 years. Rock and brush placement will occur between October 1, 2007, and November 15, 2007, and will affect approximately 1,520 linear feet on the west side of the Sacramento River along the Capay Unit of the Sacramento National Wildlife Refuge and slough bank and channel bottom. The bank revetment element will involve the placement of toe rock to provide immediate stability to the stream bank and construction below the water line. Rock removal will occur between October 1 and October 31, 2012. The activities occurring below the water line will affect existing riparian vegetation and shoreline areas primarily above the summer water surface elevation level.

*a. Short-term Construction-related Impacts*

The project site is the in an area where fry-sized fish are likely to be present during construction and revetment removal. The in-water construction activities, including the placement of rock revetment could result in direct effects to fish from the placement of rock and culvert into occupied habitat and gravel removal during peak migration periods. The project would result in localized, temporary disturbance of habitat conditions that may alter natural behavior patterns of adult and juvenile fish and cause the injury or death of individuals. These effects may include displacement, or impairment of feeding, migration, or other essential behaviors by adult and juvenile salmon, steelhead, and green sturgeon from noise, suspended sediment, turbidity, and sediment deposition generated during in-water construction activities. Some of these effects could occur in areas downstream of the project sites, because noise and sediment may be propagated downstream.

The extent of the construction activities effects is dependant upon the timing of fish presence in the action area, and their ability to successfully avoid project-related disturbance. The construction activities coincide with the peak migration periods of juvenile winter-run Chinook, which occurs between September and October. Juvenile Central Valley spring-run Chinook salmon and Central Valley steelhead migration can begin as early as November although peak abundance occurs later than the construction period. Thus, primarily, Sacramento River winter-run Chinook, CV spring-run Chinook juveniles, and CV steelhead are expected in the action area.

Green sturgeon larvae and post-larvae are present in the action area between June and October with highest abundance during June and July (CDFG 2002), and may migrate through the action area during the construction period. In addition, small numbers of juvenile sturgeon less than two years of age have been captured near the action area sporadically in the past (Jeff McLain, NMFS, pers. comm., 2006). Adult green sturgeon primarily migrate through the action area between March and July (USFWS 2002).

**(1)** ***Salmon and Steelhead.*** The placement and subsequent removal (*i.e.*, after year 5) of rock below the waterline will cause noise and physical disturbance that could displace juvenile and adult fish into adjacent habitats, or crush and injure or kill individuals. The impact of rock being placed in the river disrupts the river flow by producing surface water waves disturbing the water column; resulting in increased turbulence and turbidity. Migrating juveniles react to this situation by suddenly dispersing in random directions (Carlson *et al.* 2001). This displacement can lead them into predator habitat where they can be targeted, and injured and killed by opportunistic predators taking advantage of juvenile behavioural changes. Carlson *et al.* (2001) observed this behaviour occurring in response to routine channel maintenance activities in the Columbia River. Some of the fish that did not immediately recover from the disorientation of turbidity and noise from channel dredges and pile driving swam directly into the point of contact with predators. Feist (1991) found that noise from pile driving activities in the Puget Sound affected the general behaviour of juveniles by temporarily displacing them from construction areas. Nearly twice as many fish were observed at construction sites on non-pile driving days compared to days when pile driving occurred.

Biological studies conducted at GCID also support that predation may be higher in areas where juveniles are disoriented by turbulent flows or are involuntarily routed into high-quality predator habitat or past areas with higher predator densities (Vogel 2006). Behavioural observations of predator and salmon interactions at GCID also surmised that predators responded quickly to the release of fish during the biological tests and preyed on fish soon after they were released into the water, even when the release locations were periodically changed (David Vogel, Natural Resource Scientists, pers. comm. 2006). This is a strong indication that predators quickly respond to changes in natural juvenile salmonid behavioural responses to disturbance.

NMFS was unable to find any scientific studies or other evidence that indicated fish may be injured or killed by crushing from rock placement. Regardless, many juvenile fish are small, relatively slow swimmers, typically found in the upper two feet of the water column, and oriented to nearshore habitat. Larger fish, including adults and smolts probably would respond by quickly swimming away from the placement site, and would escape injury or death. Fry-sized fish (those that are less than 50mm) that are directly in the path of rock placement may be less likely to avoid the impact. Therefore, it is likely that the placement of large quantities of rock into this habitat has the potential to crush and injure or kill fry-sized salmon and steelhead. However, the best available outmigration data throughout the Sacramento River indicate that a large majority of fry-size listed salmon or steelhead are transported downstream during high flow conditions. If high flow conditions occur, the USFWS plans to suspend construction until flows subside. As part of the water quality control board permits, USFWS proposed to suspend construction if ongoing fishery monitoring programs indicate that large numbers of anadromous fish are within the action area. This is evidenced by the fry-sized winter-run Chinook salmon that are consistently trapped by CDFG rotary screw traps from August through December, at GCID, near RM 222. Rotary screw traps captures are low in August and peak from October through November. NMFS expects that due to the presence of fry-size fish during the placement of approximately 9,120 cubic yards of rock along 1,520 liner feet of the Sacramento River at RM 192.5R, some individuals are likely to be crushed and killed, or displaced from their preferred habitat and preyed upon by larger piscivorous fish such as pikeminnow and striped bass.

The operation of heavy equipment such as track hoes, long-reach excavator and the sound generated by construction activities may temporarily affect the behavior of migrating adult salmonids, possibly causing migration delays. Construction will be restricted to the channel edge, and would include implementation of the avoidance and minimization measures that will prevent impacts to these migration corridors. Construction activities that are limited to the shoreline are not likely to injure or kill adult winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead because their crepuscular migration behavior, and use of mid-channel, deep water habitats allows them to easily avoid nearshore disturbance and migrate through the action area without experiencing physical injury or death.

Based on similar projects conducted by CDWR and the Corps, construction activities are expected to result in periodic turbidity levels that exceed 25 to 75 Nephelometric Turbidity Units (NTUs). These levels are capable of affecting normal feeding and sheltering behavior. Based on observations during similar construction activities in the Sacramento River, turbidity plumes are not expected to extend across the Sacramento River, but rather the plume is expected to extend downstream from the site along the side of the channel. Turbidity plumes will occur during daylight hours during in-water construction. At a maximum, these plumes are expected to be as wide as 100 feet, and extend downstream for up to 1,000 feet. Most plumes extend into the channel approximately 10 to 15 feet, and downstream less than 200 feet. In contrast, the channel of the Sacramento River is several hundred feet wide. Once construction stops, water quality is expected to return to background levels within hours. Adherence to erosion control measures and BMPs such as use of silt fences, straw bales and straw wattles will minimize the amount of project-related sediment and minimize the potential for post-construction turbidity changes. Since project-related turbidity plumes will be limited to shoreline construction areas, and the Sacramento River is much wider than any plume that could be generated, NMFS expects that individual fish will mostly avoid the turbid areas of the river and use alternate migration corridors or rearing habitat. For those fish that do not avoid the turbid water, exposure is expected to be brief (*i.e.*, minutes to hours) and not likely to cause injury or death from reduced growth, or physiological stress. This expectation is based on the general avoidance behaviors of salmon and the USFWS proposal to suspend construction when turbidity exceeds Regional Board standards. However, some juveniles that are exposed to turbidity plumes may be injured or killed by predatory fish that take advantage of disrupted normal behavior. Once fish migrate past the turbid water, normal feeding and migration behaviors are expected to resume.

Toxic substances used at construction sites, including gasoline, lubricants, and other petroleum-based products could enter the Sacramento River as a result of spills or leakage from machinery or storage containers and injure or kill listed salmon and steelhead. These substances can kill aquatic organisms through exposure to lethal concentrations or exposure to non-lethal levels that cause physiological stress and increased susceptibility to other sources of mortality. Petroleum products also tend to form oily films on the water surface that can reduce DO levels available to aquatic organisms. NMFS expects that adherence to BMPs that dictate the use, containment, and cleanup of contaminants will minimize the risk of introducing such products to the waterway because the prevention and contingency measures will require frequent equipment checks to prevent leaks, will keep stockpiled materials away from the water, and will require that absorbent booms are kept on-site to prevent petroleum products from entering the river in the event of a spill or leak. NMFS does not expect the project to result in water contamination that will injure or kill individual fish.

**(2) *Green Sturgeon*.** Green sturgeon will be present in the action area during construction, and therefore may be exposed and affected by short-term increases in turbidity and suspended sediment if these increases disrupt feeding and migratory behavior activities of post-larvae, juvenile, and adult fish. Turbidity and sedimentation events are not expected to affect visual feeding success of green sturgeon, as they are not believed to utilize visual cues (Sillman *et al.* 2005). Instead, olfaction appears to be a key feeding mechanism. In addition, green sturgeon are primarily benthic, and their presence along the shoreline is not expected to be common. Injury or death from temporary increases in sediment and turbidity is not likely to adversely affect green sturgeon. Therefore, adverse effects including injury or death from construction activities are not likely.

As stated above, toxic substances such as gasoline, lubricants, and other petroleum-based products could enter the Sacramento River as a result of spills or leakage from machinery or storage containers and could also injure or kill listed green sturgeon. The effects to listed green sturgeon would be similar to those described above for listed salmon and steelhead. Again, NMFS does not expect the project to result in water contamination that will injure or kill individual fish.

*b. Longer-term (5-year) Effects*

Implementation of the proposed project is expected to alter specific characteristics of the PCEs of critical habitat in the action area. Habitat elements that are expected to be altered include structural features (bank slope, substrate size, instream woody material, and instream object cover), hydraulics (water depth and velocity), riparian habitat/overhanging shade/cover, and associated predation potential. The following analysis is consistent with similar habitat evaluations that NMFS has used to evaluate the long-term effects of bank protection projects using the U.S. Army Corps of Engineers Standard Assessment Method (SAM) (Corps 2004). The SAM was developed by the Corps, in consultation with NMFS, USFWS, CDFG and CDWR, to address specific habitat assessment and regulatory needs for ongoing and future bank protection actions in the SRBPP action area. Although the SAM model was not used to evaluate this project, the principles of the SAM were applied as an analytical framework for evaluating 5-year effects. The SAM habitat variables are described below:

- Substrate Size – Bank substrate size is used as an indicator of juvenile refugia from predators, but also as an indicator of suitable predator habitat. Increased predator density has been observed at riprapped sites relative to natural banks at studies in the Sacramento River and the Delta (Michny and Deibel 1986, Michny 1989). Substrate size also is used as an indicator of food availability. The effects of substrate size on mortality risk are expected to be greatest at small grain sizes due to a lack of cover from avian and piscivorous fish predation. Predation risk is lower at intermediate sizes close to the size of the affected life stage because small interstitial spaces offer cover from predators. Predation risk is highest when substrate sizes exceed the length of the affected life stage, because large interstitial spaces are capable of providing effective cover for piscivorous fish species. Adult life stages tend to utilize deep, mid-channel habitat and are not expected to be sensitive to changes in bank substrate size.

- Bank slope and Floodplain Habitat Availability – Bank Slope is an indicator of shallow-water habitat availability, which is important for juveniles for feeding, rearing, and refugia from high flows and predators. The relationship of bank slope to fish response is related to how variations in fish size and foraging strategies affect growth potential and expose various species and life stages to predation risk. For fry and smolts of each species, shallow water near the bank is considered to be high value because it provides refuge from predators and low velocity feeding and rearing habitat (Power 1987, Waite and Barnhart 1992, and Schlosser 1991). Smaller fish can avoid predation by piscivorous fish to some degree by selecting shallower water. Although larger fish (*i.e.*, smolts) typically use deeper water habitats, it is assumed that predation risk also increases. Adult life stages are not affected by the same predation as juveniles and tend to utilize deep, mid-channel habitat as migratory corridors. Therefore, adults are not expected to be sensitive to changes in bank slope.

  Floodplain availability is the ratio of wetted channel and floodplain area during the 2-year flood to the wetted channel area during average winter and spring flows. Floodplain availability is used as an indicator of seasonally flooded shallow-water habitat availability, which is important for juveniles for feeding, rearing, and refugia from high flows and predators. Use of seasonally inundated flooded habitat is generally considered to increase growth of juvenile salmonids due to greater access to areas with high invertebrate productivity from flooded terrestrial matter (Sommer *et al.* 2001). Predation risk in seasonally flooded areas is expected to be lower than in primary river channels due to large amounts of hiding cover and a lack of piscivorous fish. Adult life stages tend to utilize deep, mid-channel habitat and are not expected to be sensitive to changes in floodplain availability.

- Instream Structure and Submerged Vegetation – The value of instream structure and vegetation to salmonids has been directly demonstrated by various studies. Instream structure provides juvenile refugia from predators (Michny and Hampton 1984, Michny and Deibel 1986). Instream structure is used as an indicator of food availability, feeding station availability, and as cover and resting habitat for adults. Instream structure provides high quality resting areas for adults and juveniles, cover from predation, and substrate for macroinvertebrate production (USFWS 2000, Lassettre and Harris 2001, Piegay 2002).

  Submerged and aquatic vegetation provides refugia from predators, and food availability. Rearing success is strongly affected by aquatic vegetation (Corps 2004). Biological response to aquatic vegetation is influenced by the potential for food production and cover for sensitive life stages. Because salmonid fry and juveniles are commonly found along shore in flooded vegetation (Cannon and Kennedy 2003) increases in aquatic and submerged terrestrial vegetation is expected to result in a positive salmonid response (*i.e.*, increased growth, reduced risk of predation). Adult salmonids are not expected to be sensitive to changes in aquatic or submerged terrestrial vegetation.

- Overhanging Shade – The value of overhanging shade provides juvenile refugia from predators, and food availability. Numerous studies have shown the importance of overhanging shade to salmonids. Overhanging shade provides overhead cover, and allochthonous inputs of leaf litter and insects which provide food for juveniles. Michny and Hampton (1984), and Michny and Deibel (1986) found that juvenile salmonid abundance was highest in reaches of the Sacramento River with shaded riparian cover.

***(1) Adult Salmon and Steelhead Migration.*** Adult fish use the river channel at the project sites as a migration pathway to upstream spawning habitat, and changes in nearshore habitat conditions are expected to have negligible effects on migrating adults because adult Chinook salmon and steelhead generally use deep, mid-channel habitats. Thus, the area affected by the project is not necessarily habitat that is used by adults. Additionally, based on post-project field evaluations of similar projects constructed by the Corps in 2006, these types of shoreline alterations do not appear to obstruct or delay the upstream migration of adult fish and will not affect their ability to successfully reach upstream spawning habitat. Therefore, NMFS expects that adult fish are not likely to be delayed, injured or killed as a result of the proposed shoreline alterations, since most adult fish are expected to migrate through deeper mid-channel pathways and will avoid direct exposure to the altered areas.

***(2) Juvenile Salmon and Steelhead Rearing and Migration.*** The implementation of the project would result in a temporary loss of riparian vegetation and IWM along the affected shorelines. However, cover losses would be immediately followed by construction of a benched shoreline, installation of IWM, and revegetation at a 2:1 ratio immediately adjacent to the site that will replace the loss of riparian vegetation.

Along the 1,520 foot Proposed Revetment Area, the existing bank generally consists of steep slopes of about 1:1, based on the Temporary Maintenance Project permitting report provided by Ducks Unlimited Inc. The stone toe would be constructed with a 10:1 cross grade and could therefore significantly reduce the slope of the west bank within the proposed action area.

The change in bank slope from the existing condition to a very gradual slope under the proposed action is expected to affect listed species through the alteration of important habitat variables. Shallow water depth and relatively low water velocities are important habitat variable for evaluated species, because they provide areas suitable for predator avoidance, and increased food availability. The constructed bank slope of 10:1 is expected to provide juveniles with habitat highly valued for its contribution to predator avoidance from larger piscivorous fish, and increased macroinvertebrate foraging opportunities. These beneficial affects to juvenile salmonids would be realized immediately at the completion of construction, and throughout the five-year period of evaluation.

Existing bank substrate size in the action area can be characterized as primarily containing loose sands and loamy fine sand with little cobble or gravel sized substrate. The proposed action would place 1,520-feet of rock toe and tree revetment on the west side of the river.

Habitat use studies on the Feather River (Cavallo et al. 2003), Sacramento River (CDFG 1983; Michny and Deibel 1986; Michny 1989) and in several western states (Peters *et al.* 1998; Tiffan *et al.* 2002) have shown lower juvenile salmonid rearing densities, and higher predator densities, along riprapped banks. Presumably, these observations are in relation to naturally eroding banks containing substantive amounts of predator escape cover such as IWM, vegetation and other hydraulic roughness/cover elements. A variety of particle sizes, characterized by a heterogeneous surface substrate particle size composition, provides high habitat suitability value for juvenile salmonids *via* foraging opportunities and predator avoidance/escape cover.

The particle size distribution proposed for use in the bank revetment portion of the proposed action would be expected to provide benefits for juvenile salmonids in foraging and predator avoidance. The 0.75 ft.-sized rock would provide flow breaks, hydraulic roughness, and velocity refugia elements important to juvenile salmonids as shelter and feeding stations. A veneer would be placed on top of the 0.75 feet-sized rock to fill interstitial space created by large quarry stone, in order to reduce larger refuges for predator fish species. The "veneer" would consist of stone less than 8 inches in diameter, or of "pit run rock" which consists of various sizes of rock. In addition to providing water velocity refugias, feeding stations, predator avoidance shelters, and predator exclusion habitat, the heterogeneous surface substrate particle size composition also would be expected to increase the amount of habitat suitable for aquatic macroinvertebrate colonization. These beneficial effects to juvenile salmonids would be realized immediately at the completion of construction, and throughout the five-year period of evaluation.

There is currently little or no IWM along much of the west bank of the proposed action area. For the most part, vegetation above the eroding bank consists of grasses, and continued erosion will not recruit substantive, if any, IWM. The exception is the riparian vegetation along the estimated 250 linear feet of shoreline in the downstream portion of the action area. The specific amount of presently inundated IWM at this location has not been estimated. If the west bank of the Sacramento River were allowed to continue to erode, flows would undercut existing stands of vegetation resulting in the deposit of small and large woody material into the Sacramento River.

The proposed action includes a tree and/or brush component of the proposed revetment that consists of several tree and/or brush clusters, each occupying 40 to 50 linear feet with 10 to 15 feet clearings between clusters. This placement results in approximately 1,322 total linear feet of IWM along the 1,520 linear feet of the Sacramento River's west bank within the action area.

The IWM is expected to provide benefits in foraging and predator avoidance. A net increase of approximately 1,072 linear feet of IWM is expected immediately following revetment construction. IWM placement structures are not expected to substantially decay over the five-year evaluation period. These beneficial effects to juvenile salmonids would be realized immediately at the completion of construction, and throughout the five-year period of evaluation.

Approximately 250 linear feet of Valley/Foothill Riparian vegetation (as per aerial photography estimates) exists along the downstream portion of the revetment zone on the west bank of the Sacramento River. Riparian forest in this area consists of a tall overstory of deciduous broadleaf trees comprised primarily of valley oak. Other native riparian forest species include Fremont cottonwood, box elder (*Acer negundo*), Oregon ash (*Fraxinus latifolia)*, western sycamore (*Platanus racemosa*) and northern California black walnut (*Juglans californica* var. *hindsii*). Understory species in this riparian forest community include poison oak (*Toxicodendron diversilobum*), wild blackberry (*Rubus ursinus*), Himilayan blackberry (*Rubus discolor*), wild grape (*Vitis californica*), elderberry (*Sambucus mexicana*) and saplings of tree species. The dense riparian habitat along the lower end of the revetment zone serves as the primary source of overhanging shade/cover within the project area, as the remaining 1,270 linear feet is essentially devoid of overhanging shade/cover.

The placement of rock and tree revetment along the valley/foothill riparian habitat would impact 250 linear feet of bankline valley/foothill riparian habitat. The impacts to riparian vegetation would replace SRA habitat with reveted bank, and discontinue natural recruitment of IWM at this restricted portion of the west bank of the Sacramento River.

Overhanging shade/cover resulting from the 250-feet of riparian vegetation provides predator avoidance/escape cover from avian and aquatic predators, increased productivity and nutrient inputs from allochthonous leaf litter, and increased macroinvertebrate food sources for listed salmonids. However, the loss of these habitat features is expected to be affected by the revegetation of 3.5 acres of river bank immediately upstream from the riveted area which is expected to provide an overall increase in the amount of riparian vegetation (hence, overhanging cover/shade) as the newly planted riparian vegetation matures over time, relative to existing conditions. In addition, the immediate large amount of increased IWM resulting from the proposed action is expected to provide fish with increased predator avoidance/escape cover and feeding stations. These beneficial IWM effects would be realized immediately at the completion of construction, and throughout the 5-year period of evaluation.

Upon removal of the rock revetment five years following initial construction, it is anticipated that the tree and/or brush cluster rehabilitation would be disturbed and/or removed, and the bank essentially would revert to baseline conditions. After bank revetment material removal, continued erosion will not recruit substantive amounts of IWM because vegetation above the eroding bank generally consists of grasses. The exception is the riparian vegetation associated with the estimated 250 linear feet of riparian habitat bordering the Sacramento River in the downstream portion of the project. As the west bank of the Sacramento River continues to erode in the future, flows will continue to undercut these stands of vegetation, resulting in the deposit of small and large woody material into the Sacramento River. In addition, the Capay Unit of the SRNWR currently is being restored to riparian floodplain habitat, which not only would provide some

IWM recruitment over the 5-year planning period, but would be expected to provide additional IWM recruitment over time, as the restored habitat matures.

(3) ***Adult Green Sturgeon Migration and Holding***. Adult green sturgeon move upstream through the project sites between March and July. Long-term changes in nearshore habitat are expected to have negligible effects on adults because adult sturgeon use deep, mid-channel habitat during migration. The long-term effects of the proposed project related to North American green sturgeon adults would primarily be related to the alteration of the Sacramento River below the waterline as migrating and holding adults utilize benthic habitat. The ecosystem changes from the removal or reduction of riparian vegetation and IWM could affect potential prey items and species interactions that green sturgeon would experience while holding. However, the potential for these adverse effects to occur is minimized considerably in the project design and any such effects would decrease through time as a result of the proposed project's conservation measures. Therefore, NMFS expects that adult green sturgeon are not likely to be injured or killed as a result of the project since most fish are expected to migrate through deeper mid-channel pathways and will avoid direct exposure to project sites.

(4) ***Larval, Post-larval, and Juvenile Green Sturgeon Rearing and Migration***. The action area is utilized by larvae and post-larvae and to a lesser extent, juvenile southern DPS of North American green sturgeon for rearing and migration purposes. Although it is believed that larvae and post-larvae as well as juveniles primarily are benthic (with the exception of the post-larvae nocturnal swim-up believed to be a dispersal mechanism), the removal or reduction of riparian vegetation and IWM likely impacts potential prey items and species interactions that green sturgeon would experience while rearing and migrating. These changes are minimized considerably in the project design and the effects of the riparian and IWM removal or reduction would decrease over time as a result of the proposed project's conservation measures.

NMFS expects green sturgeon responses to long-term, project-related habitat conditions to be similar to juvenile salmonids described above. Overall, there will be a temporary loss of aquatic and riparian vegetation and IWM along a small portion of the affected shorelines. However, the immediate placement of a 10:1 bench, with IWM, and 3.5 acre of revegetation would provide a net increase in habitat features beneficial to juvenile green sturgeon.

*(5) 5-Year Effects on Critical Habitat.* Impacts to the designated critical habitat of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CV steelhead include the modification of approximately 1,520 linear feet of nearshore aquatic and riparian areas used primarily for rearing and migration.

Potential impacts would be related to changes in bank substrate, and reductions in vegetation and shade caused by conversion of the natural bank to rock revetment. The most substantial impacts to these PCEs would result from loss or modification of riparian vegetation, IWM, shallow-water habitat, and the increase in bank substrate size. These losses and modifications could potentially affect the PCEs by reducing instream cover and food production. However, the project's integrated conservation measures, including placement of a "veneer" of small substrate of the angular rock, replacement of a 1:1 slope with a 10:1 slope, extensive placement of IWM, and 3.5 acres of revegetation will ultimately result in neutral or improve rearing and migration PCEs for five years. Once the project features are removed after five years, PCEs will return to baseline conditions. This change is also expected to be either neutral or beneficial as other planned habitat conservation measures mature or develop over the 5 year project period.

2. Effects of Gravel Removal

During excavation of gravels from the gravel bar, a 5 to 10-foot berm will be left on the outer edge of the dry bar to separate the Sacramento River and Big Chico Creek from the dredging activities. The area inside the gravel bar would be excavated to about 5-feet below the fall low-flow (4,000 cfs Sacramento River flow) water surface elevation. This will isolate the activities from the flowing river and prevent impacts to listed species. The temporary stream crossing over Big Chico Creek will be installed according NMFS fish passage guidelines to assure continuous passage during the project. Upon completion of the gravel bar dredging activities, the temporary stream crossing will be removed and any impacted vegetation will be restored. A slight increase of turbidity may occur as the stream crossing is constructed and angina when it is removed. The amount of turbidity and the length of exposure are expected to be minimal. The effects to salmonids and green sturgeon will be smaller in scale, but otherwise similar to those described under section *a. Short-term Construction-related Impacts.* Based on the project description, NMFS has determined that the gravel removal element of the proposed project is not likely to adversely affect Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, and their designated critical habitat, and the southern DPS of North American green sturgeon.

### C. Interdependent and Interrelated Actions

Regulations that implement section 7(b)(2) of the ESA require biological opinions to evaluate the direct and indirect effects of Federal actions and actions that are interrelated with or interdependent to the Federal action to determine if it would be reasonable to expect them to appreciably reduce listed species' likelihood of surviving and recovering in the wild by reducing their reproduction, numbers, or distribution (16 U.S.C. §1536; 50 CFR 402.02).

NMFS does not anticipate any interdependent or interrelated actions associated with the proposed action.

## VI. CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

Cumulative effects include non-Federal riprap projects. Depending on the scope of the action, some non-Federal riprap projects carried out by State or local agencies do not require Federal permits. These types of actions and illegal placement of riprap are common throughout the Sacramento River. The effects of such actions result in continued fragmentation of existing high-quality habitat, and conversion of complex nearshore aquatic habitats to simplified habitats that affect salmonids in ways similar to the adverse effects associated with the proposed action.

Additional cumulative effects may result from the discharge of point and non-point source chemical contaminant discharges. These contaminants include selenium and numerous pesticides and herbicides associated with discharges related to agricultural and urban activities. Contaminants may injure or kill salmonids by affecting food availability, growth rate, susceptibility to disease, or other physiological processes necessary for survival.

## VII. INTEGRATION AND SYNTHESIS

The purpose of this section is to summarize the effects of the action and then add those effects to the impacts described in the *Environmental Baseline* and *Cumulative Effects* sections of this biological opinion in order to determine whether or not the proposed action is likely to jeopardize their continued existence.

### A. Summary of Impacts of the Proposed Action on Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead

NMFS expects that the proposed action will result in short-term, adverse, construction-related impacts, and habitat impacts that will injure, and kill juvenile Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead. Juveniles are expected to be affected by placement and removal of revetment because of their small size, reliance on nearshore aquatic habitat, and vulnerability to factors that injure or kill them, or otherwise affect their growth and survival. Construction-related factors include noise or crushing of fish from rock placement and barge activity, and changes in water quality that temporarily modify natural behavior and may reduce their growth or expose juvenile fish to predation. Adults should not be injured or killed because their size, preference for deep water, and their crepuscular migratory behavior will enable them to avoid most temporary, nearshore disturbance.

The implementation of BMPs and other on-site measures also will minimize impacts to the aquatic environment and reduce project-related effects to fish. In addition, and with the exception of the occurrence of winter-run Chinook salmon, peak migration events correspond with periods of high river flows, when in-river construction activities are likely to be complete. Furthermore, only one cohort, or emigrating year class, out of perhaps three to five within each salmon and steelhead population will be affected by construction. NMFS expects that actual injury and mortality levels will be low relative to the overall population abundance of all cohorts. Because of these considerations, construction-related impacts will be a small, short term impacts that are unlikely to cause negative population trends.

The number of juvenile fish that will be injured or killed as a result of construction related impacts will be low because the most significant loss of habitat condition and function is limited to the low-flow fall water surface elevation levels, while the majority of juvenile fish are expected to be present during winter and spring months, when seasonal water elevations are higher, and project conservation measures are available to the species. Although Federally listed anadromous fish may be present in the action area during the fall months, abundance is relatively low compared to the number of fish that are present during winter months. Furthermore, although there will be short-term impacts to critical habitat, this is not expected to have significant consequences to the species, because the sites will contain numerous integrated habitat features such as shallow-water benches and large concentrations of IWM that will function to provide immediate rearing and refugia habitat until the riparian vegetation becomes established and covers the wetted perimeter of the river channel.

Longer term (5-year) habitat changes related to the bank protection are expected to be neutral or beneficial to juvenile fish. This is largely because, the modified habitat elements (*i.e.*, bank substrate, and riparian vegetation) will be replaced by habitat features intended to provide on-site benefits to juvenile rearing and survival (*i.e.*, small substrate, IWM, riparian revegetation, and shallow bank slope). Removal of these features will return the habitat to baseline conditions, which also would be either a neutral or beneficial change as other planned habitat conservation measures mature or develop over the 5 year project period.

Adult fish will not be affected because they generally use deep, mid-channel habitats within the action area as a migration pathway to upstream spawning habitat, and changes in nearshore habitat conditions generally have negligible effects on migrating adult fish.

**B. Impacts of the proposed action on the Survival and Recovery of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CV steelhead**

The assessment of factors affecting the species in action area, described in the *Environmental Baseline* section of this biological opinion, described some of the habitat degradations and other factors that are affecting the listed species throughout the action area. The *Environmental* Baseline found that many of adverse factors are being corrected through restoration or other corrective actions, and that because of these actions the likelihood of the species continued existence has begun to improve in recent years. Actions have been undertaken to reduce juvenile entrainment at diversions and to restore riverine habitats such riparian habitat and channel complexity. Consistent with these recent efforts, the proposed action has specifically been designed to replace altered or loss habitat features on site The proposed implementation of the integrated conservation measures that will ensure that that the action prevents incremental habitat degradation and fragmentation. Although some injury or death to individual fish is expected from construction activities, successful implementation of all conservation measures is expected to improve migration and rearing conditions, and the growth and survival of juvenile salmon and steelhead.

Because of this, when considered in addition to the *Environmental* Baseline, the proposed action is not expected to reduce the likelihood of survival and recovery of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead within the action area.

This is largely due to the fact that the project will replace and restore the habitat on-site as conservation measures, but also because construction-related impacts will be temporary and will not impede adult fish from reaching upstream spawning and holding habitat, or juvenile fish from migrating to downstream rearing areas. The number of individuals actually injured or killed by construction is expected to be low because actions will be small. Additionally, Lindley *et al.* (2007) have found that the extant subpopulations, and to some degree the ESUs as a whole, are meeting viability criteria for abundance. The proposed action is expected to have little influence on other ESU viability criteria for population spatial connectivity, diversity, population growth rate.

**C. Summary of the Impacts of the proposed action on the Southern DPS of North American Green Sturgeon**

NMFS also expects the action to adversely affect the Federally listed southern DPS of the North American green sturgeon. Adverse effect to this species is expected to be limited to migrating and rearing larvae, post-larvae, juveniles and holding adults. Juveniles are expected to be affected most significantly because of their small size, reliance on aquatic food supply (allochthonous food production), and vulnerability to factors that affect their feeding success and survival. Construction activities will cause disruptions from increased noise, turbidity, and inwater disturbance that may injure or kill larvae, post-larvae, and juveniles by causing reduced growth and survival as well as increased susceptibility to predation. Adverse affects to adults are primarily limited to the alteration of habitat below the waterline affecting predator-prey relationships and feeding success. NMFS expects responses to long-term, project-related habitat conditions to be similar to juvenile salmonids, as described above in *Long-term Effects of the Propose Action on Anadromous Salmonids*. However, because green sturgeon are not as near-shore oriented as juvenile Chinook salmon, the relative proportion of the green sturgeon population that will be affected by the short- and long-term conditions should be low.

**D. Impacts of the proposed action on the Survival and Recovery of the Southern DPS of North American Green Sturgeon**

The adverse effects to southern DPS of North American green sturgeon within the action area are not expected to affect the overall survival and recovery of the DPS. This is largely due to the fact that the project will compensate for temporary and permanent habitat losses of habitat through implementation of on-site and off-site conservation measures. Construction-related impacts will be temporary and will not impede adult fish from reaching upstream spawning and holding habitat, or larvae, post-larvae, and juvenile fish from rearing or migrating to downstream rearing areas. The number of individuals actually injured or killed is expected to be undetectable and negligible and, population-level impacts are not anticipated. Because of this, the proposed action is not expected to reduce the likelihood of survival and recovery of the southern DPS of North American green sturgeon within the action area.

### E. Impacts of the proposed action on Critical Habitat

The purpose of this section is to consider the effects of the action on habitat in addition to the assessment of the current condition and function of PCEs and their contribution to the conservation value of habitat in order to determine whether or not the proposed action in likely to adversely modify designated critical habitat.

Impacts to the designated critical habitat of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead include the short- and long-term modification of approximately 1,520 lf of nearshore aquatic and riparian areas that are designated critical habitat. PCEs at the project site include riverine areas for rearing and migration. NMFS CHART (2005b) described existing PCEs within the action area as ranging from good condition to degraded, with isolated fragments of high quality habitat. Even with these degraded conditions, the CHART report rated the conservation value of the entire action area as high because it is used as a rearing and migration corridor for all populations of winter-run Chinook salmon and a significant proportion of CV spring-run Chinook salmon and CV steelhead.

Because of the project's integrated conservation measures, including placement of a "veneer" of small substrate of the angular rock, replacement of a 1:1 slope with a 10:1 slope, extensive placement of IWM, and 3.5 acres of revegetation. NMFS expects that the action will contribute positively to the growth and survival of fish using the habitat, and ultimately improve rearing and migration PCEs. Therefore, we do not expect project-related impacts to reduce the conservation value of designated critical habitat of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CV steelhead.

## VIII. CONCLUSION

After reviewing the best available scientific and commercial information, the current status of CV spring-run Chinook salmon, and CV steelhead, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is NMFS' biological opinion that the M&T Ranch project, as proposed, is not likely to jeopardize the continued existence of

Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, or CV steelhead, and is not likely to destroy or adversely modify their designated critical habitat.

After reviewing the best available scientific and commercial information, the current status of the southern DPS of North American green sturgeon, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is NMFS' biological opinion that the M&T Ranch project, as proposed, is not likely to jeopardize the continued existence of the southern DPS of the North American green sturgeon.

## VIII. INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by NMFS as an act which kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not the purpose of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The listing of the southern DPS of North American green sturgeon became effective on July 7, 2006, and some or all of the ESA section 9(a) prohibitions against take will become effective upon the future issuance of protective regulations under section 4(d). Because there are no section 9(a) prohibitions at this time, the incidental take statement, as it pertains to the southern DPS of North American green sturgeon does not become effective until the issuance of a final 4(d) regulation.

The measures described below are non-discretionary, and must be undertaken by the USFWS so that they become binding conditions of any grant, contract, or permit, as appropriate, for the exemption in section 7(o)(2) to apply. The USFWS has a continuing duty to regulate the activity covered by this incidental take statement. If the USFWS: (1) fails to assume and implement the terms and conditions, or (2) fails to require the contractors to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or contract document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the USFWS must report the progress of the action and its impact on the species to NMFS as specified in the incidental take statement (50 CFR §402.14(i)(3)

### A. Amount or Extent of Take

NMFS anticipates incidental take of Sacramento River winter-run Chinook salmon, CV steelhead, CV spring-run Chinook salmon, and the southern DPS of North American green sturgeon from impacts related to construction and through long-term impairment of essential behavior patterns as a result of reductions in the quality or quantity of their habitat. Take is expected to be limited to rearing and smolting juveniles.

NMFS cannot, using the best available information, quantify the anticipated incidental take of individual Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CV steelhead, and the southern DPS of North American green sturgeon because of the variability and uncertainty associated with the population size of each species, annual variations in the timing of migration, and uncertainties regarding individual habitat use of the project area. However, it is possible to describe the conditions that will lead to the take.

Accordingly, NMFS is quantifying take of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CV steelhead, and the southern DPS of North American green sturgeon incidental to the action in terms of ecological surrogates associated with the extent and duration of the construction, and long-term impacts as described above. The following ecological surrogates indicating the level of incidental take caused by project activities are anticipated:

1. Construction-related turbidity that extends up to 100 feet from the shoreline, and 1,000 feet downstream, along all project reaches for construction that occurs from October 1, 2007 to November 15, 2007, and October 1, 2012, to October 31, 2012.

2. The placement of large rock into the river channel for revetment along 1,520 linear feet of river bank between October 1 and November 15, 2007, and the removal or revetment between October 1, 2012, and October 31, 2012.

Anticipated incidental take may be exceeded if project activities exceed the criteria described above, if the project is not implemented as described in the BA prepared for this project, or if the project is not implemented in compliance with the terms and conditions of this incidental take statement.

### B. Effect of the Take

NMFS has determined that the above level of take is not likely to jeopardize Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, or the southern DPS of North American green sturgeon. The effect of this action in the proposed project areas will consist of fish behavior modification, temporary loss of habitat value, and potential death or injury of a small number of juvenile Sacramento River winter-run Chinook salmon, Central Valley steelhead, and Central Valley spring-run Chinook salmon, and the southern DPS of North American green sturgeon.

### C. Reasonable and Prudent Measures

NMFS has determined that the following reasonable and prudent measures (RPMs) are necessary and appropriate to minimize the incidental take of listed anadromous salmonids.

1. Measures shall be taken to maintain, monitor, and adaptively manage all conservation measures throughout the life of the project to ensure their effectiveness.

2. Measures shall be taken to minimize the impacts of bank revetment by implementing integrated onsite and offsite conservation measures that provide beneficial growth and survival conditions for juvenile salmonids, and the southern DPS of North American green sturgeon.

### D. Terms and Conditions

1. Measure shall be taken to maintain, monitor, and adaptively manage all conservation measures throughout the construction of the project to ensure their effectiveness.

    a. The USFWS shall make every reasonable effort necessary to ensure that the construction activities minimize the loss of existing riparian vegetation and allow for the establishment of riparian vegetation at winter and spring seasonal water surface elevations within the project footprint.

    b. The USFWS shall provide a project summary and compliance report to NMFS within 60 days of completion of construction. This report shall describe construction dates, implementation of project conservation measures, and the terms and conditions of the final biological opinion; observed or other known effects on listed species, if any; and any occurrences of incidental take of the Sacramento River winter-run Chinook salmon, Central Valley steelhead, and Central Valley spring-run Chinook salmon.

    c. The USFWS shall provide a second project summary and compliance report to NMFS within 12 months of the issuance of the final biological opinion. This report shall provide a progress update on implementation of the outstanding off-site conservation measures; and details on the off-site location, and project design development for the off-site conservation requirements.

2. Measures shall be taken to minimize the impacts of bank revetment by implementing integrated onsite conservation measures that provide beneficial growth and survival conditions for juvenile salmonids.

   a. The USFWS shall ensure that to the maximum extent practicable, conservation measures are constructed at elevations that maximize seasonal inundation rates, and corresponding availability to anadromous fish, while maintaining bank protection integrity, and promoting the establishment of riparian vegetation suitable for the site.

   b. The USFWS shall minimize the removal of existing IWM to the maximum extent practicable, and that where appropriate, removed IWM will be anchored back into place. NMFS shall be contacted prior to the removal of any tree greater the 4 inches dbh.

   c. The USFWS shall ensure to the maximum extent practicable, and without adversely affecting engineering, or the growth and survival of existing vegetation, that measures are taken to integrate soil into project sites by using means that are determined to be feasible and appropriate.

Reports and notifications required by these terms and conditions shall be submitted to:

Sacramento Area Office
National Marine Fisheries Service
650 Capitol Mall, Suite 8-300
Sacramento California 95814-4706
FAX: (916) 930-3629
Phone: (916) 930-3600

## IX. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. These conservation recommendations include discretionary measures that the USFWS can implement to avoid or minimize adverse effects of a proposed action on a listed species or critical habitat or regarding the development of information. NMFS provides the following conservation recommendations that would avoid or reduce adverse impacts to listed salmonids:

1. The USFWS, under the authority of section 7(a)(1) of the Act, should implement recovery and recovery plan-based actions within and outside of traditional flood

damage reduction projects. Such actions may include, but are not necessarily limited to restoring natural river function and floodplain development.

2. The USFWS should continue to focus on acquiring, retaining, restoring and creating river riparian corridors in pursuit of the recovery of the listed salmonid species within their property.

3. The USFWS should work towards implementation of a long-term solution for the M&T project that promotes natural riverine geomorphologic processes and functions.

4. The USFWS should continue to pursue actions that preserve and restore riparian habitat and meander belts along the Sacramento River with the following actions: (1) avoid any loss or additional fragmentation of riparian habitat in acreage, lineal coverage, or habitat value, and provide in-kind mitigation when such losses are unavoidable (*e.g.*, create meander belts along the Sacramento River by levee set-backs), (2) assess riparian habitat along the Sacramento River from Keswick Dam to Chipps island and along Delta waterways within the rearing and migratory corridor of juvenile winter-run Chinook salmon, and (3) develop and implement a Sacramento River and Delta Riparian Habitat Restoration and Management Plan (*e.g.*, restore marshlands within the Delta and Suisun Bay).

To be kept informed of actions minimizing or avoiding adverse effects, or benefiting listed or special status species or their habitats, NMFS requests notification of the implementation of any conservation recommendations.

## X. REINITIATION OF CONSULTATION

This concludes formal consultation on the M&T Ranch Channel Maintenance. Reinitiation of formal consultation is required if: (1) the amount or extent of taking specified in any incidental take statement is exceeded; (2) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) the action, including the avoidance, minimization, and compensation measures listed in the *Description of the proposed action* section is subsequently modified in a manner that causes an effect to the listed species that was not considered in the biological opinion; or (4) a new species is listed or critical habitat is designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, formal consultation shall be reinitiated immediately.

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**Enclosure 2**

## MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT

### ESSENTIAL FISH HABITAT CONSERVATION RECOMMENDATIONS

| | |
|---|---|
| Agency: | U. S. Fish and Wildlife Service<br>Sacramento National Wildlife Refuge Complex |
| Activity: | Bank protection work and gravel removal in the Sacramento River near Chico, California |
| Consultation Conducted By: | Southwest Region, National Marine Fisheries Service |
| File Number: | 151422SWR2005SA00115 |
| Date Issued: | OCT 0 2 2007 |

### I. IDENTIFICATION OF ESSENTIAL FISH HABITAT

This document represents the National Marine Fisheries Service's (NMFS) Essential Fish Habitat (EFH) consultation based on our review of information provided by the U.S. Fish and Wildlife Service (USFWS) on the proposed revetment and gravel removal at M&T Ranch on the Sacramento River at river mile (RM) 192.5R (M&T Ranch project). The Magnuson-Stevens Fishery Conservation Act (MSA) as amended (U.S.C 180 et seq.) requires that EFH be identified and described in Federal fishery management plans (FMPs). Federal action agencies must consult with NMFS on activities which they fund, permit, or carry out that may adversely affect EFH. NMFS is required to provide EFH conservation and enhancement recommendations to the Federal action agencies. The geographic extent of freshwater EFH for Pacific salmon in the Sacramento River includes waters currently or historically accessible to salmon within the Sacramento River.

EFH is defined as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. For the purpose of interpreting the definition of essential fish habitat, "waters" includes aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include areas historically used by fish where appropriate; "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities; "necessary" means habitat required to support a sustainable fishery and a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers all habitat types used by a species throughout its life cycle.

The biological opinion for the M&T Ranch project addresses Chinook salmon listed under the both the Endangered Species Act (ESA) and the MSA that potentially will be affected by the proposed action. These salmon include Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*), and Central Valley spring-run Chinook salmon (*O. tshawytscha).* This EFH consultation will concentrate on Central Valley fall-/late fall-run Chinook salmon (*O. tshawytscha*) because they are covered under the MSA but not listed under the ESA.

Historically, Central Valley fall-run Chinook salmon generally spawned in the Central Valley and lower-foothill reaches up to an elevation of approximately 1,000 feet. Much of the historical fall-run spawning habitat was located below existing dam sites and the run therefore was not as severely affected by water projects as other runs in the Central Valley.

Although fall-run Chinook salmon abundance is relatively high, several factors continue to affect habitat conditions in the Sacramento River, including loss of fish to unscreened agricultural diversions, predation by warm-water fish species, lack of rearing habitat, regulated river flows, high water temperatures, and reversed flows in the Delta that draw juveniles into State and Federal water project pumps.

**A. Life History and Habitat Requirements**

Central Valley fall-run Chinook salmon enter the Sacramento River from July through December, and late fall-run enter between October and March. Fall-run Chinook salmon generally spawn from October through December, and late fall-run fish spawn from January to April. The physical characteristics of Chinook salmon spawning beds vary considerably. Chinook salmon will spawn in water that ranges from a few centimeters to several meters deep provided that the there is suitable sub-gravel flow (Healey 1991). Spawning typically occurs in gravel beds that are located in marginally swift riffles, runs and pool tails with water depths exceeding one foot and velocities ranging from one to 3.5 feet per second. Preferred spawning substrate is clean loose gravel ranging from one to four inches in diameter with less that 5 percent fines (Reiser and Bjornn 1979).

Fall-run Chinook salmon eggs incubate between October and March, and juvenile rearing and smolt emigration occur from January through June (Reynolds *et al.* 1993). Shortly after emergence, most fry disperse downstream towards the Sacramento-San Joaquin Delta and estuary while finding refuge in shallow waters with bank cover formed by tree roots, logs, and submerged or overhead vegetation (Kjelson *et al.* 1982). These juveniles feed and grow from January through mid-May, and emigrate to the Delta and estuary from mid-March through mid-June (Lister and Genoe 1970). As they grow, the juveniles associate with coarser substrates along the stream margin or farther from shore (Healey 1991). Smolts generally spend a very short time in the Delta and estuary before entry into the ocean.

## II. PROPOSED ACTION.

The USFWS proposes to implement stream bank revetment and gravel removal at RM 192.5. The proposed action is described in the *Description of the proposed action* section of the preceding biological opinion (Enclosure 1).

## III. EFFECTS OF THE PROJECT ACTION

The effects of the proposed action on Pacific Coast salmon EFH would be similar to those discussed in the *Effects of the proposed action* section of the preceding biological opinion (Enclosure 1) for endangered Sacramento River winter-run Chinook salmon, threatened Central Valley spring-run Chinook salmon, and threatened Central Valley steelhead. A summary of the effects of the proposed action on Central Valley fall-/late fall-run Chinook salmon are discussed below.

Adverse effects to Chinook salmon habitat will result from construction related impacts and impacts related to modification of aquatic and riparian habitat at the project site. Primary construction related impacts include placing rock toe revetment along approximately 1,520 linear feet of riverbank. Integrated conservation measures to minimize adverse effects of the erosion repair will be applied to the site. Conservation measures include construction of a seasonally inundated bench that will integrate instream woody material (IWM) to be placed both below and above the mean summer water surface elevation (MSW) to provide habitat complexity, refugia, and food production of juvenile anadromous fish.

In-channel construction activities such as vegetation removal and rock placement will cause increased levels of turbidity. Turbidity will be minimized by implementing the proposed conservation measures such as implementation of BMPs and adherence to Regional Board water quality standards. Fuel spills or use of toxic compounds during project construction could release toxic contaminants into the Sacramento River. Adherence to BMPs that dictate the use, containment, and cleanup of contaminants will minimize the risk of introducing such products to the waterway because the prevention and contingency measures will require frequent equipment checks to prevent leaks, will keep stockpiled materials away from the water, and will require that absorbent booms are kept on-site to prevent petroleum products from entering the river in the event of a spill or leak.

There will be short and long-term losses of habitat value. Long-term impacts are expected to adversely affect EFH for juvenile salmon at average fall and summer water surface elevation for the life of the project. However, at winter and spring water surface elevations, adverse effects to EFH will be short-term, lasting from 1 to 5 years. Long-term effects of the project (*i.e.*, 5 to 50 years) will be positive as riparian habitat starts to reestablish. Overall, the action will result in a net improvement in habitat conditions essential to Chinook salmon survival and growth, especially under winter and spring flow conditions, when the majority of juvenile salmon are outmigrating through the action area. This net improvement is expected to maintain the conservation value of the habitat for Chinook salmon and avoid habitat fragmentation that typically is associated with riprapping.

## IV. CONCLUSION

Upon review of the effects of M&T Ranch project, NMFS believes that the project will result in adverse effects to the EFH of Pacific salmon protected under the MSA.

## V. EFH CONSERVATION RECOMMENDATIONS

Considering that the habitat requirements of fall-run within the action area are similar to the Federally listed species addressed in the preceding biological opinion (Enclosure 1), NMFS recommends that Terms and Condition 1a through 1c; and 2a through 2d, as well as all of the Conservation Recommendations in the preceding biological opinion prepared for the Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead ESUs be adopted as EFF Conservation Recommendations.

## VI. ACTION AGENCY STATUTORY REQUIREMENTS

Section 305(b)(4)(B) of the MSA and Federal regulations (50 CFR § 600.920) to implement the EFH provisions of the MSA require Federal action agencies to provide a detailed written response to NMFS, within 30 days of its receipt, responding to the EFH conservation recommendations. The response must include a description of measures adopted by the Agency for avoiding, mitigating, or offsetting the impact of the project on Pacific salmon EFH. In the case of a response that is inconsistent with NMFS' recommendations, the Agency must explain their reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the proposed action and the measures needed to avoid, minimize, mitigate, or offset such effects (50 CFR 600.920(j)).

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